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SOUTH BOSTON POWER STATION

Ultimate Development, 125,000 Kw.; 100,000 Tons Coal Handling and Storage Plant; 39 Miles of Underground Transmission Lines and 6 Substations, Arranged for a Capacity of 38,000 Kw.

WITHIN THE HUNDRED SQUARE miles which include Boston's Metropolitan District a million and a half people live and work. To provide adequate transportation facilities for this shifting, fast-growing population is the problem of the Boston Elevated Railway Co. Stretched across the territory in which the road operates, binding together more than 40 cities and towns, are about 500 miles of elevated, surface and subway tracks on which nearly 6,000,000 car trips are made each year. Three hundred million passengers, calling for quick, scheduled service, are carried annually.

Business and pleasure make big demands on a metropolitan transportation system like the Boston Elevated, so that although between 1902 and 1910 the company raised its generating capacity 70 per cent, by the end of 1910 the average hourly maximum load had risen above the station capacity. The problem of additional power was immediately met with a response that was practically conclusive, and before the end of 1911 the company had in service an entirely new alternating-current system of power generation and distribution, planned in every feature, from the coal storage to the substations, on lines that will meet whatever growth of population may come.

Stone & Webster's engineers made a careful analysis of the first cost and distribution cost of both alternating and direct-current systems, and reported that the use of alternating current would result in an economy which would increase from year to year with the growth of the railway. The report recommended the construction of an alternating-current station on tide-water in South Boston, from which high-tension current would be carried by underground cables to 6 new substations. Late in 1910 the Boston Elevated Railway Co. authorized the expenditure of several million dollars to carry out these recommendations, and retained the Stone & Webster Engineering Corp. as designing and constructing engineers.

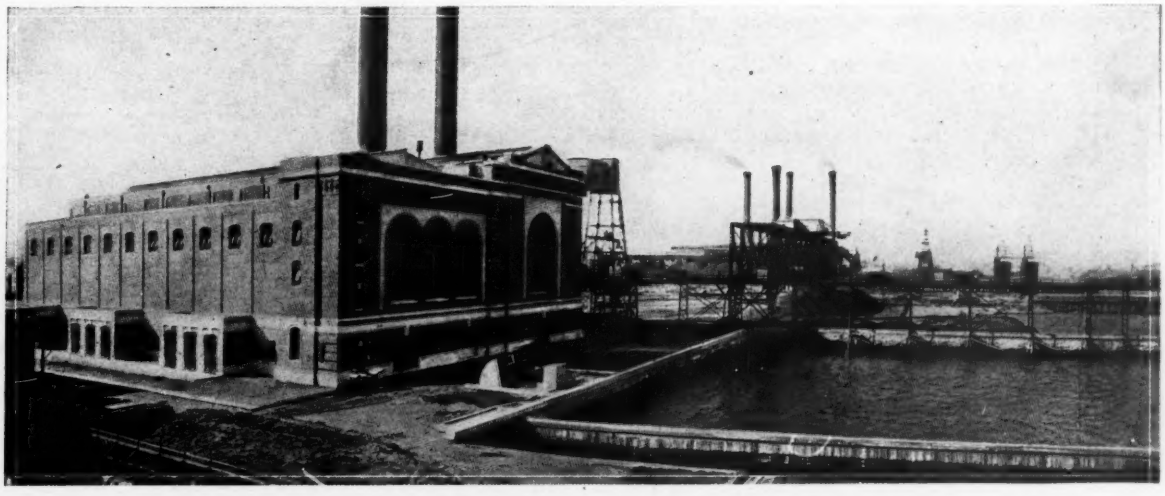


FIG. 1. SOUTH BOSTON STATION AND COAL STORAGE

Contract for this work was signed in the middle of November, 1910; on January 12, 1911, ground was broken for the main power station, and late in the summer the Elevated Company asked that work be pushed with all possible speed, in order to meet the power demands of the new Cambridge subway, which was then expected to be in operation by Thanksgiving.

On Nov. 14, 1911, 307 days after ground was broken, the station, with machinery complete for 30,000 kw., was put in commercial operation. During the same period a 100,000-ton coal handling and storage

FIG. 2. UNLOADING WHARF AS SEEN FROM ROOF OF POWER STATION

plant, the largest private plant in Boston, was built, and a distributing system, consisting of about 40 miles of 13,200-volt underground transmission lines with several substations, was installed.

General Arrangement

POWER station and coal storage plant are on a 25-acre tract in South Boston, facing north on the ship channel. The frontage is 800 ft., and the depth is 1300 ft. between First Street and the harbor line. The coal wharf parallels the ship channel and conveniently berths the largest vessels, unloading them when fully equipped with 3 towers, as planned, at the rate of 600 tons an hour.

The power station building is on the east of the property, and sets 600 ft. back from the harbor line at the head of a wide channel, from which the condensing water is taken. The building is 164 ft. wide, and the present length is 166 ft. through the boiler room and 239 ft. through the turbine room. The ultimate length will be 450 ft., which will provide for an installation of 125,000 kw. By the construction of other stations on ample sites ranged around the coal storage tract, an ultimate station capacity of 300,000 kw. is possible on the South Boston property. This is double the ultimate capacity of all the water power plants of over 1000 hp., now operating in the State of Massachusetts.

Architectural features of the station, planned by Robert S. Peabody, suggest the great power which it is planned to house. The north elevation, facing the water front, has the effect of massiveness. On the turbine-room front of the building are 3 high, arched windows set off by a square turret, concealing the switch gallery lean-to on the eastern side of the building. Broad pilasters, carrying a decorative pediment, flank the single arched window in the front of the boiler room. Dover brick is used on the exterior, the stone trimmings being artificially cast. The turbine-room floor is laid with red quarry tiles. Above the slate mopboard is a cream-colored, enameled brick dado, about 25 ft. high. The rest of the interior walls are repressed brick, with an addition of terra-cotta panelling just below the roof trusses. Over the centers of boiler room and turbine room are liberal skylights, equipped with continuous bridge ventilators.

Coal Storage

TO the west of the station is the coal storage area, 300 ft. by 400 ft., with a present capacity of 50,000 tons. A tract of about the same size is to be filled in between the present area and the unloading wharf. With this land reclaimed, 100,000 tons of coal can be stored at one time.

Two steam-operated towers on the unloading wharf run on rails laid to 24-ft. centers, and are built to unload 400 tons of coal an hour. Coal is dropped from the towers to cable cars, which travel along the trestle, on the eastern side of the storage area, and across the 300-ft. traveling transfer bridge which spans the dumping ground. After dropping their loads, the cars proceed on the cable way which is looped around the bridge and back to the unloading wharf. The transfer bridge carries an electrically-operated traveling reclaiming plant and grab bucket which will hoist coal, when needed from storage, at the rate of 200 tons an hour. The grab bucket dumps its loads from the storage tract into the cable cars, which discharge into a hopper at the northwestern corner of the station. In case a vessel is unloading, the cars run directly to the hopper, which discharges into a crusher. The power station bunkers, 80 ft. above the crusher, are reached

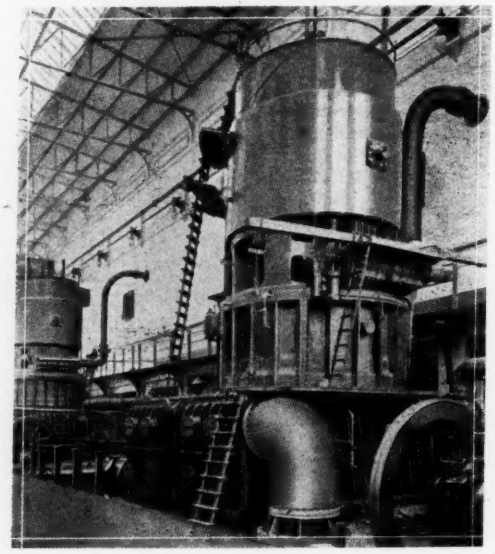


FIG. 4. ONE OF THE 15,000-KW. TURBINES

by elevated conveyors in 2 stages, one extending to a car-loading hopper and a return belt running to the top of the conveyor tower and thence by horizontal belts to the bunkers.

Preliminary Work

LOW, tide-water land made preliminary construction on the power station particularly difficult. For 2 months before any structural work could be attempted, 7 steam-hammer pile drivers were engaged in driving over 1500 concrete piles for the reinforced concrete footings.

Under the intake and discharge tunnels 35-ft. piles were driven, spaced 3 ft. 6 in., center to center, in each

direction. Excavation and pile driving for these tunnels and for column and wall footings were carried on behind a temporary cofferdam built across the head of the basin in front of the power house site.

Boiler Room

BY the first of April the foundations were ready for the steel, and a few weeks later boilers were being placed. The boiler room, 85 ft. wide and 160 ft. long, has 16 Babcock & Wilcox water-tube type boilers, each rated at 600 hp. on the basis of 10 sq. ft. of heating surface per horsepower.

They are fitted with Babcock & Wilcox superheaters, designed for 100 deg. superheated at 200 lb. pressure. The boilers are connected to a 14-in. header mounted about 2 ft. above the floor. From this header, connections are carried through the boiler-room wall at a height of 16 ft. to the turbines. Each boiler is equipped with 7 retort Taylor stokers guaranteed to operate the boilers up to 240 per cent of the rating for a period of 4 hr. The stokers are driven by 2 vertical engines on each side of the firing aisle. They are fed from reinforced concrete and steel bunkers, 12 ft. wide and 21 ft. deep, located above the boilers on each side of the light well, coal dropping from the bunkers into a traveling weighing crane, which distributes fuel to the stokers.

Forced draft is supplied to the boiler furnaces by 3 Sturtevant multivane fans, delivering 120,000 cu. ft. of air a minute to a duct under the firing aisle, from which connections lead to each furnace, blast duct dampers and stoker engines being controlled automatically by a pressure regulator. From the furnaces the ashes drop into reinforced concrete hoppers under the boiler-room floor, and thence into ash cans running on a narrow-gage track in the basement. The ashes are used for filling in the future coal storage area.

Water is supplied to the boilers by 2 1000-gal. and one 500-gal. centrifugal pumps. Each group of 8 boilers is equipped with a Cochrane feed-water heater and a Worthington water weigher. There are 2 stacks, 13 ft. in diameter, rising 215 ft. above the boiler-room floor, supported on the structural steel work.

Turbine Room

JOINING the boiler room on the east is the turbine room, 235 ft. in length by 56½ ft. in width, spanned by a 100-ton, electrically driven crane. The partition wall is carried by girders at the level of the boiler room floor, which is 17 ft. above the engine-room floor, leaving a bay 22 ft. wide under the boilers. With the exception of a 75-kw. exciter set and a 200-kw. lighting set on the main floor of the turbine room, all the auxiliary machinery is installed in this bay.

The initial equipment consists of 2 15,000-kw. Curtis vertical turbines with General Electric 6600-volt alternating-current generators. A third unit of 15,000 kw., for which there is already sufficient boiler capacity, has been ordered and will be installed at

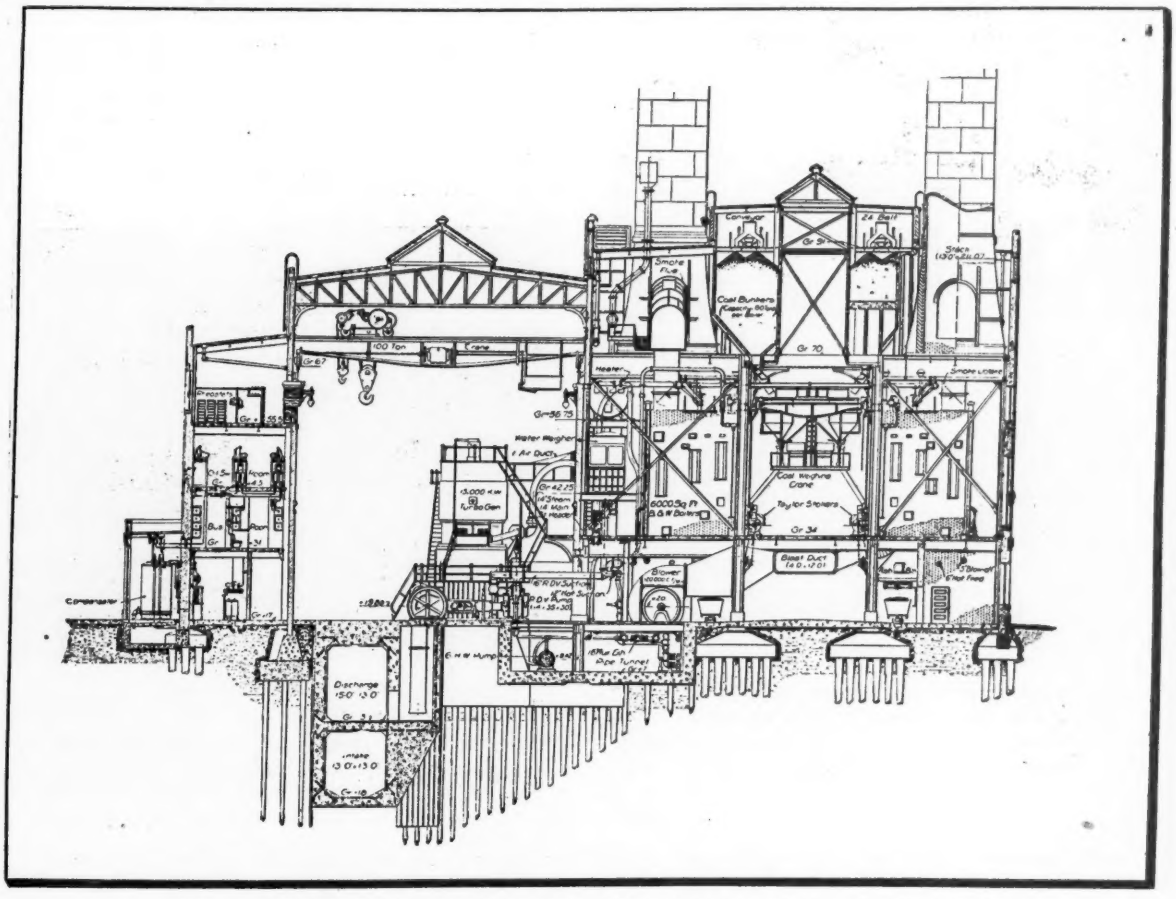


FIG. 3. CROSS-SECTION OF THE POWER HOUSE LOOKING SOUTH FROM THE WATER FRONT

once. Incorporated in the base of each of the turbines is a Worthington surface condenser, having 29,000 sq. ft. of cooling surface and being capable of condensing 225,000 lb. of steam an hour.

A condenser circulating pump is mounted in a pit 8 ft. deep at one side of each condenser. On the floor level at the other side is a dry vacuum pump. The condensing water is drawn from the intake tunnel through 2 26-in. risers by a centrifugal circulating pump with a capacity of 35,000 gal. a minute.

The water is led through an outlet tunnel, which runs directly over the intake as far as the north end of the building, where it turns to the east and empties behind a diverting bulkhead extending 600 ft. to the harbor line.

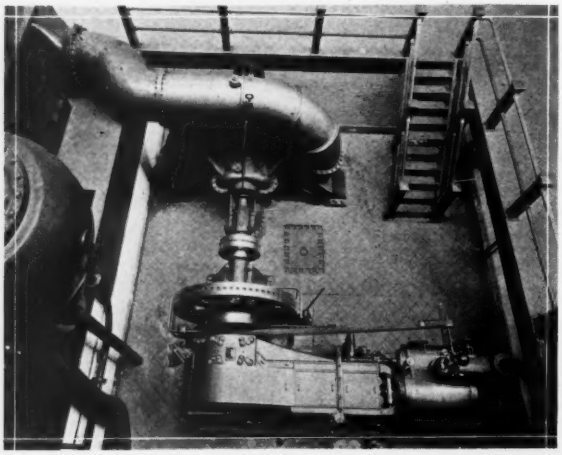


FIG. 5. ONE OF THE CONDENSING WATER CIRCULATING PUMPS

Intake Tunnel

THE intake tunnel at the opening in the sea wall is divided by longitudinal walls, into 4 passages, each 7 ft. 8 in. wide by 13 ft. high. Back of these openings, at an angle of 15 deg. from the vertical, are both stationary and revolving screens, the latter carrying endless chains with a series of buckets which catch the harbor debris and dump it into receiving baskets on the sea wall.

Generating Equipment

THERE are 2 125-kw., turbine-driven exciter units and one 75-kw., motor-driven exciter unit. The main generators are 25-cycle machines generating at 6600 volts, and the current is stepped up to 13,200 volts by compensators, or auto-transformers, inserted in the circuit between the generators and the high-tension station bus bars. The auto-transformers are located in brick compartments built outside the station wall, and are arranged so that they may be rolled out on trucks for repairs and cleaning. There are 3 auto-transformers for each generator, each with a full capacity of 2500 kw.

Switching Apparatus

ALL of the switching apparatus is located on a 4-story bay running the entire length of the east side of the turbine room. On the ground floor are station lighting and power transformers and the outgoing feeder potheads. The second floor is occupied by the generator and feeder bus bars, which are in compartments made of monolithic reinforced concrete, designed to protect every portion of the high potential system in the station.

All switching is done by motor-operated, remote-control oil switches, mounted in concrete compartments on the third floor, directly over the bus bars, disconnecting switches being installed in the bus room so that the oil switches may be entirely cut off from the lines and buses for cleaning and repairs. The operating room is on the fourth floor, and the turbine benchboard operator has before him the instruments for observing and controlling speed, voltage, load and connections of the turbines.

At his right is a telegraph signal which makes a printed record of messages sent and received, with the exact time the orders are transmitted and the names of the operators on duty at that time. Opposite the turbine benchboard is the feeder benchboard, which also controls the exciter system for the station and the battery outfit for the operation of the oil switches. There are in the initial installation 7 outgoing feeders, transmitting current to the 6 substations, located at Coolidge Corner in Brookline, Kendall Square in Cambridge, Arlington, Malden, East Boston and Roslindale.

The Coolidge Corner substation supplies the lines in the Brookline and Brighton Districts, formerly fed by the Allston power station, now abandoned, and the Central and Harvard stations. The station at Kendall Square furnishes current for the new Cambridge subway in addition to the surface lines formerly fed from the East Cambridge power station.

FIG. 6. BOILER ROOM

The Arlington station has replaced the Somerville gas-engine station, and relieves the Harvard station of part of its load. The station at Malden replaces the gas-engine station in Medford, and relieves the Charleston power station of a heavy load. It will feed the lines in Malden, Medford and Everett. The station supplying the East Boston District joins the old East Boston steam station. At Roslindale is the only new substation on the south side of the city.

QUESTION HAS OFTEN arisen why, with its low fuel cost, the producer gas plant does not invade the power field in central station work. An interesting light on this point is the statement of E. D. Dreyfus before the A. S. M. E. that "At the present prevailing price of fuel, a producer plant is commercially limited to sizes under 1000 kw." This leaves the producer a large field, but bars it from the big central station.

THE ISOLATED PLANT SITUATION

Some Reasons Why Central Stations Grow and Some Isolated Plant Needs

By Rossiter Holbrook

I HAVE DIVIDED THIS subject into 4 different heads and treated each as briefly and concisely as possible.

The divisions of the subject that I shall take up in order are:

1—The cause of the central station's growth and development.

2—The effect or possible help from legislation, or public service boards, in protecting isolated plant operation and growth.

3—The deficiencies and most needed improvements in the operation of isolated plants.

4—The principal reasons for architects omitting isolated plants from large buildings.

And now for the first of these divisions:

The causes of the central station's growth and development is a subject, in my opinion, which covers a multitude of sins. I will, however, point out a few of the good reasons and leave them to their multitude.

Plant Knowledge Is Power

THEY realize rightly that knowledge is power, and the biggest, yes, the only source of knowledge is through experiment or experience. Perhaps we may have to exclude a few of the geniuses who seem to know things instinctly, I am dealing with the average now. How do they acquire this knowledge without going to the source every time? By teaching others and being taught by others in return.

One of the greatest little lesson books is the "N. E. L. A. Bulletin." When a central station wishes to investigate a subject it drops a question in the question box and, Presto! the question is answered. It would have taken them months perhaps to go to the source of knowledge for this answer.

Another ready reference for arguments and ideas is the "Solicitor's Hand Book." I won't go into details regarding this book, but suffice it to say that a good hustling magnetic young man with brains—the latter not always necessary—ought to be able to give a possible central station customer food for thought if he only used what the book contains. I will venture to say, however, that the compilers of this book have learned more about soliciting central station business since the first edition than they knew before. Why? Because a good teacher with earnest students learns nearly as much from them as they do from him. These central station people tell each other what they know, and in this way are a mutual benefit society.

Another reason for their growth is their tremendous publicity work, through advertising in papers. Under this head, however, comes what might be called false publicity, such as the publicity given to failures in the isolated plant field, and so forth.

Still another cause for central station growth is the constant seeking for young college and school men to take up the work. For example, on a Friday evening in the latter part of January, W. Wallace Ker gave a lecture to the De Witt Clinton High School, New York City, on the "Production and Supply of Electricity by Central Stations." Look through the graduation theses of our mechanical and electrical schools of today and we will find that central station thought predominates. The graduates come from college, work in central stations until they are thoroughly imbued with the central station idea, and then are thrust on the community as consulting engineers. These are the men that architects get.

Providing the Capital

THE 2 biggest reasons for central station growth are: "The money they use to grow with," and the first investment by the prospective private plant owner.

The officials go to the public and say: "We have a solid 6 per cent, gilt-edge paying proposition," and the man with the money looks the proposition over and decides to invest, which is perfectly right. But there are others of us that are property holders who are forced to invest, in the sense that the company is given a franchise to run through the streets. For this they may pay a sum of money which can be classed as an interest on this investment. We are all in the company, then, whether we wish to be or not; and if this is so, they should treat all the stockholders alike.

I am not going into the discussion of discrimination of rates, except to say that the New York Edison Co. has made a profit of $36,000,000 since 1905, wholly from the retail and small wholesale consumer. The fact I wish to emphasize is that it is the public's money they are using with which to make their profits, and, who is getting the benefit of it?

When it comes to the possible plant owner, he has to get together the total investment himself. Then the central station man who has been getting people to invest in central station 6 per cent stock turns right around and says to the prospective owner: "Why sink your money in a private power plant that may pay 10 per cent when you might get a larger percentage of profit if you put your money into our business?" Incidently, it has been shown conclusively that an isolated plant under favorable conditions has been a better than a 40 per cent paying proposition. You will notice that I have not gone into the rate question, because I stated that I would speak of a few of the good reasons for central stations' growth, and I feel that this rate question comes under the "Multitude of Sins."

Legislation and Public Service

AND, now, for the possible assistance from legislation and from public service boards in protecting the isolated plant industry: The isolated plant situation can be greatly benefitted by proper legislation, and action by the public service boards, but very little legislation or protection has ever been given for public benefit without being backed by an aroused public opinion or by spirited individuals. The easiest and quickest way to arouse this public opinion is by the newspaper publicity, and there is no question of municipal government at the present time that would be more beneficial to the community than a just and proper regulation of electric rates, but it is hard to find the newspaper that is willing to give up the advertising of the central station companies in order that they may publish news that will arouse this public opinion. I fail to see how they would be the losers,

however, for the reason that they would derive tremendous public good will by so doing.

This matter of rates is being quietly thrashed out by Public Service Commissions now, but unless the public at large is thoroughly aroused through the newspapers to the great benefit it will derive by a just settlement of this question, it will probably be years before the proper action will be forthcoming. This is thoroughly emphasized by the fact that the lawyers of the New York Edison Co. have made the statement that they intended carrying the matter to the highest court before submitting to any regulation. The only thing to be done is to create such a demand for publicity of this question that the newspapers cannot afford to ignore it.

The question should not be based on the reduction of the maximum, but upon the increase of the minimum rate. The argument being that according to the central station's reports to the Public Service Commissions they are charging the large consumer less than the cost of production and distribution. We all know that the result of this is to make up the deficit by overcharging the small consumer. We ought to try and make that one of the planks in an election platform. Cleveland made electricity rates one of the biggest questions in its last mayoralty election.

It is not necessary to point out what the results would be if the low rates were raised, although most of us know that even with the rates as they are the private power plant can compete and make an excellent showing. It would, however, eliminate to a great extent the hard struggle we are having to make the prospective plant owner realize this.

We must arouse public opinion or nominate some man for public office on this platform, and then legislation will be quick in coming and the public service board will not have such a long fight to carry on.

Isolated Records Needed

I HAVE tried to emphasize in taking up the first division of my subject that "Knowledge Is Power." In dealing with the third part, namely, The Deficiencies and Most Needed Improvements in the Operation of Private Power Plants, I wish to revert to that same adage. Whether a man is in business, in a profession or is an operating engineer, it always holds true that the knowledge he possesses is not going to do him harm, but it is what he does not know that the other man will take advantage of, and in this connection I wish to bring up the subject of keeping records and logs. This is one of the greatest deficiencies in the operation of private power plants at the present time, and one of the principal reasons for their being closed down. An operating engineer need never fear the closing down of his plant, if he can prove the results he is getting.

I have gone into engine rooms and tried to get information regarding the operation of the plant. I have had to tell my family history and all about myself before being able to get any information, and then when it was forthcoming I realized that I had wasted hours. I have gone into other plants and had false information given me, and still others where the engineer said his employer did not wish to disclose costs.

I have gone into plants where the engineer didn't know the horsepower of his units. I say units because the plant I had in mind was a 3-unit plant, consisting of 60-kw. units and one 120-kw. unit. I asked what their capacity was and was told that the 2 small ones were about 50 kw. and the larger one he thought was 90 kw. These units were practically new and manufactured by firms of high standing and should have been able to take care of the load that was specified on the name plate which was in plain sight. The engineer had been in charge 3 months. I suppose he would start one of the small ones and when it began to knock with overload he would throw in the other small one or the large one.

I have always found that the engineer who knew and could prove what his plant was doing never was backward about giving out any information wanted.

This idea that central stations will use it, to close down the plant is ridiculous. They don't use the information that we have; they use the information that we haven't. And it does not take them long to find this out either. If they find the engineer has complete records up to date, their course of procedure is to move on to the next plant.

In order to keep these records and get the data, the engineer has, oftentimes, insurmountable difficulties to overcome, because it is necessary to have certain instruments and in some cases the employer is not willing to spend the money. But I have found that the engineer who is anxious to make a fine showing will get these instruments in some way. Recording meters, indicators, scales, water weighing devices and other testing instruments are more or less a necessity in any well regulated plant, and without them the records cannot be complete.

The record blanks themselves should have a great deal of study put on them, so that they will tell the story. And in connection with this blank, there is one column in the monthly cost sheet that should have special mention, namely, the deferred charges. If it becomes necessary to buy new grate bars retube a boiler, purchase a new pump or make a new investment of this kind, it is not fair to the plant or the engineer or the owner that this charge should be made against one month, because these things have a long life before renewal, and it seems more reasonable that a comparatively long time be given to charge them off. The deferred charge column contains the total of what is left over of these investment charges from each month, after a certain percentage, say 10 per cent, has been deducted for the current month.

Training the Force

ONE more point I wish to make is that every engineer should make his engine room a training school for engineers. This is a point that cannot be too strongly emphasized. The successful business men of today are the men that have been able to get efficient work out of their employes and the only way to do this is to have the employe know what he is doing and why he is doing it and to realize that only through his efficiency can the best results be obtained, and if he has anything in him he will try to produce these results.

There is no better training school for chief engineers than the teaching of the men under him, because the questions asked by them and the mistakes made by them will continually bring up new points about a subject of which the chief may have felt he had a complete knowledge. First-class operating engineers are at a premium in New York City at the present time. I asked a prominent operating engineer where he got his men from and he said not in the city, as good men were seldom out of a job.

If we wish to work to increase isolated plants, we must also increase the supply of competent engineers

to operate them, and that end of the work must of necessity be taken care of by the present men.

The Architect's Viewpoint

MY fourth subject, the Principal Reasons for Architects Omitting Isolated Plants from Large Buildings, could be answered in most cases by the one big reason, namely, "Lack of Knowledge," and, what is more, a great many of them don't care to know. It is not in their line, in the first place, and they do not care to give up the room for a plant, because it often means extra excavations and extra cost and they dislike to overstep the bounds of their preliminary estimate.

"Why should they advise a plant?" is perhaps a good question for me to ask. Who is going to the architect the minute it is learned that he has the job? Who is going to him to talk and advise and persuade him that a plant is the only logical course. Who is going to him to give him the benefit of engineering knowledge, just to persuade him that a plant is necessary? Nobody.

But, on the other hand, what are the central station people doing? Read the newspapers—read the great proportion of the electrical journals—read the Edison Monthly. What do they tell him? How many thousands of dollars are they spending on high salaried men who work entertaining, advising the use of central station service, casually calling attention to isolated plant failures, hiding isolated plant successes, and offering expert engineering knowledge free (the latter very much biased, but useful of its kind).

The central stations have gone so far as to be able, in some manner we will not mention now, to get so-called consulting engineers who have already installed private plants to advise against the installation of the same and even shamelessly speak in public against those installed. These engineers have done this, as I have said, after having advised some of their earlier clients to put in plants.

Is there any reason why architects should be in favor of plants?

Taking Pointers from the Onlooker

LASTLY I wish to take up the point of the lack of desire on the part of engineers to be told anything about their plants. For some unknown reason some engineers have an idea that they can't be told anything about their plants. They know more about them than anyone else no doubt, but they would be surprised at the amount of information a rank outsider could give them that would increase the efficiency of their plant.

The following example will probably show what I mean.

Every one of us, at different times, has probably been the looker on at a game of cards or chess or checkers. We have nearly always seen plays made that we would not have played. A wrong card led, a checkmate that could have been avoided, or a checker that could have been jumped. Why is this? In most cases the man who makes these wrong plays is probably as good, if not a better, player than any of the gallery. Why does he make these mistakes? One of the biggest reasons is because he is more intensely interested in the game than the observer. We say, then, "If this is so he should play the game better than the observer." This is not necessarily the case at all. He has most likely laid out a course of procedure and is so intent upon carrying it out that he pays little attention to the rest of the game and thinks that if he achieves the one play that he has in view he will win the game. This sometimes works, but more often fails.

Haven't you gone into your brother engineer's sanctum, the engine room, and seen things that you would have fixed, changes you would have made, little details that would have increased the efficiency and decreased the operating cost? But brother engineer is a little touchy and you think the best thing to do is to keep mum.

Perhaps it is under special conditions, but the best thing that could happen would be for brother engineer to get over that touchiness and realize that although he has the best interests of that plant at heart, yet he may be so intensely interested in perfecting one part of his plant that he is not giving the whole its proper attention. Let the operating engineer keep continually before his eyes the 2 words "Learn" and "Teach."

EMERGENCY PUMP REPAIR

By M. E. Copley

JUST before 10 p. m., after I had retired, and was soundly sleeping, my good wife aroused me to say that some one wanted me at the 'phone, and when I answered the call, the familiar voice of the night man informed me that a boiler pump had failed; after asking a few questions, to aid me in any mental preparation I might make while getting from home to the plant, I hung up the receiver and lost no time in getting there. The pump is a single outside packed plunger pump and very reliable. I found that the stuffing box for valve stem had broken in two, just at the end of the threaded end where the gland nut screws in; it was necessary to keep this pump in service, even if it had been in shop hours, we could not have spared it long enough to have the old stuffing box removed and a new one put in.

A hasty investigation of my curiosity shop (commonly called scrap pile) revealed one plate ½ by 1½ in. with a 1-in hole near each end; one plate ½ by 2½ in. with a ¾-in. hole in center, and a ⅝-in. hole near each end; 2 rods ½ by 18 in. with thread and nut at each end; by sawing a slot into center hole, wide enough to slip down over valve stem, outside of gland nut, placing off-set bends in the ½-in. rods, so that they could be passed through holes in first plate (which was laid across rear end of steam chest) along side of steam chest and through end holes of second plate I was able to clamp the 2 parts of stuffing box together and start the pump in a very short time. This happened on a Tuesday night and we ran until our regular stopping time on Sunday morning without any more trouble except that the packing had begun to leak enough to be annoying. After stopping we found that there was no way to get the gland nut off—break being flush with end of nut—so here was another emergency. We had on hand some home-made metallic packing for valve stems of another pump; I took one of the outside rings, filed a groove around the center of its circumference, sawed it diagonally on opposite sides, cut two sets of ebonite rings, placed one set next to each of the broken parts, placed the metallic ring between, then took some fine copper wire and wound closely around in the groove I had made, pulled up the clamping apparatus, and all was well. Now some engineers might have found a better way, if so a description of it would be of interest.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

TRANSFORMERS

Their Installation, Operation and Care

By Carl D. Knight

TRANSFORMERS in their simplest form consist of a core of sheet steel punchings or laminations, as they are called, upon which are wound 2 coils of wire insulated from each other and the core. One of these coils is called the primary coil, and is connected to the alternator supplying the power. The other coil is called the secondary, and to it is connected the lamps or other device which is to receive the power. Figure 1 shows the core and coils of a modern commercial transformer.

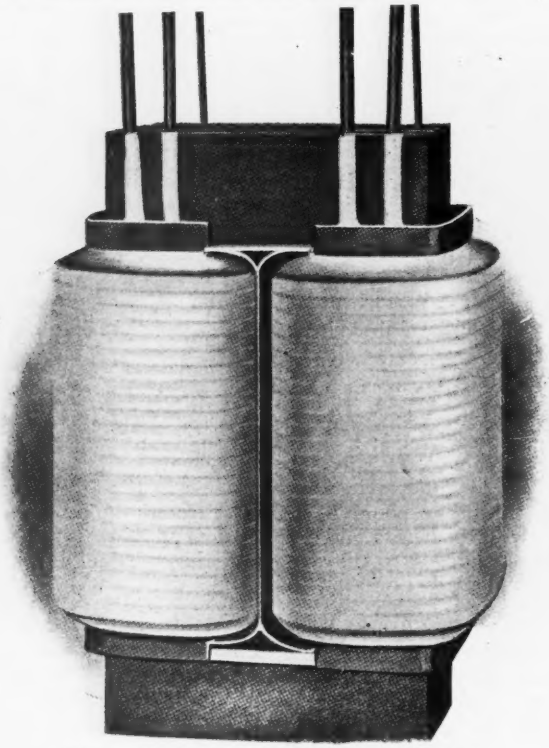


FIG. 1. COILS AND CORE OF A TRANSFORMER

The most common use of the transformer is to change alternating current from one voltage to another. When used to change from a high voltage to a lower it is called a step down transformer, and a step up when used to change from a low to a higher voltage. The same transformer may be used as a step up or a step down transformer depending upon which coil is used as a primary. When transformers are used in this manner—that is, to change alternating current from one voltage to another—they are called constant potential transformers.

Relation of the primary voltage to the secondary voltage is called the ratio of the transformer, and depends directly upon the relative number of turns in the 2 coils. Thus, if a transformer be used to change an alternating current of 1000 volts to one of 100 volts the ratio is said to be 10 to 1, and the coil to which the 1000 volts is applied would have 10 times as many turns of wire as the 100 volt coil. The currents in the 2 coils would of course depend upon the load, but for any given load, the current in the 100 volt coil will be nearly 10 times greater than the current in the 1000 volt coil.

FIG. 2. X-RAY VIEW OF TRANSFORMER IN CASE

Insulation and Cooling

IN order to protect the windings of a transformer from mechanical injury the core and coils are placed in an iron case. Figure 2 shows an X-ray view of a core and coils when placed in the iron case. The space between the coils and the case is usually filled with oil. This oil serves a double purpose. It helps to

insulate the different coils from the core and case and from each other, and also serves to carry the heat which is generated in the core and coils, due to the losses in them, to the outside case where it is dissipated into the surrounding air.

The losses just spoken of are never large, varying from 8 or 9 per cent in the small sizes to as low as 2 per cent or even less in the larger sizes. This small loss, however, is often large enough to require special means for dissipating the heat resulting from it. Medium size transformers often have their cases ribbed, as shown in Fig. 3, to aid in getting rid of the heat, very large sizes have pipes immersed in the oil which carry circulating water (Fig. 4), others provide means for taking the oil from the tank and cooling it outside and returning it to the bottom.

Oil used in transformers is called transil oil. It has the appearance of lubricating oil and must be free from acid, moisture, and mineral impurities, and have a fairly high flash point.

In all transformers of high enough voltage so that the oil is depended upon for insulation, extra precau-

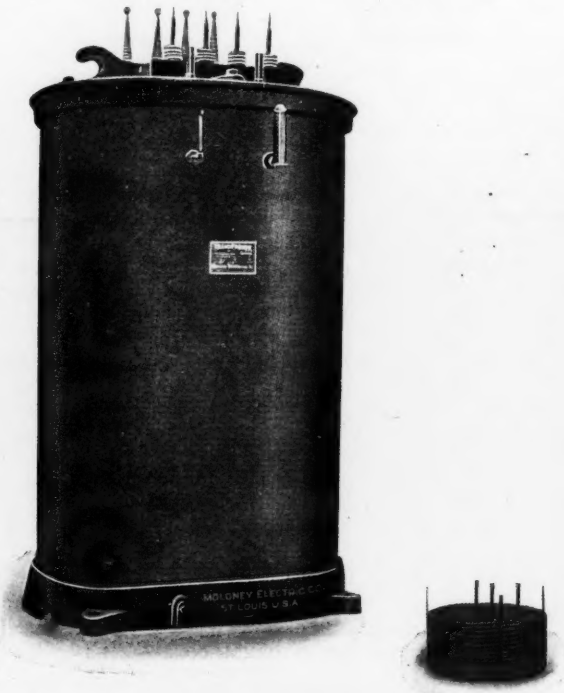


FIG. 4. WATER COOLED TRANSFORMER AND COIL

tions must be observed in keeping the oil free from moisture. Such transformers, after being installed and filled with oil, but before being put into service, are subjected to what is known as the drying out process. This consists of heating the oil to a temperature barely above the boiling point and keeping it at that temperature until all the moisture has been driven off. This insures that not only is the oil free from moisture, but also any moisture that may have collected in the transformer windings is driven off. In very high voltage installations, oil drying apparatus is installed, through which the oil is pumped, thus insuring a continuous supply of dry oil.

Another method of cooling that is used quite extensively in transformers used in railway substations, is to force air into the base of the transformer and allow it to blow out the top and sides. These so-called air blast transformers are usually set over a pit, air being forced into the pit at about one ounce pressure by motor driven blowers. This method of cooling is not applicable to transformers having potentials above 13 thousand volts. The absence of oil reduces the fire risk to some extent.

Practically all transformers are shipped from the manufacturer ready for installation except for filling with oil.

Location of Transformers

SMALL transformers are nearly always suspended from pole cross arms by iron hangers, furnished for the purpose, as shown in Fig. 5. Those which are too large to be suspended in this manner are set upon

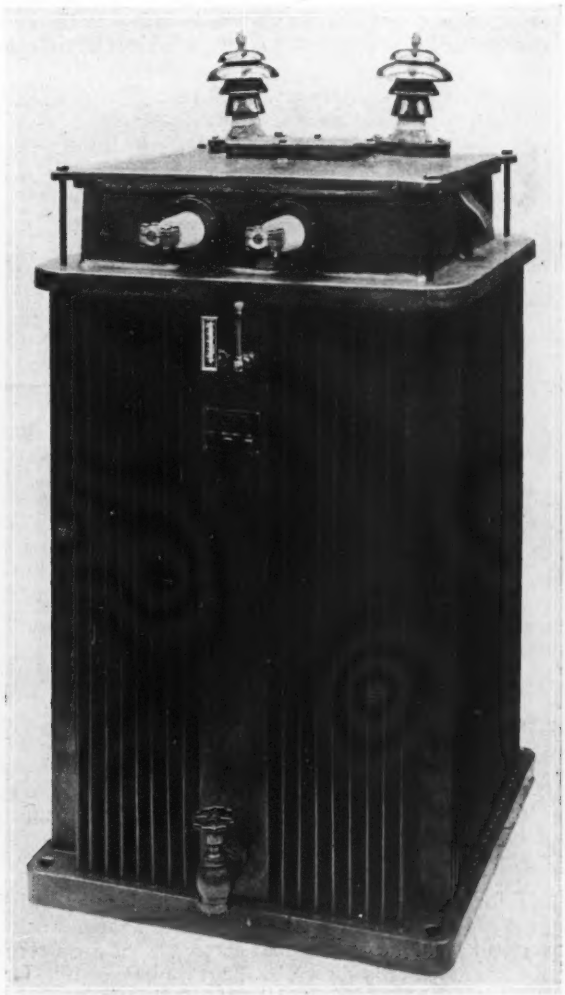


FIG. 3. TRANSFORMER WITH CORRUGATED CASE TO AID IN RADIATING HEAT

a platform about 10 ft. above the ground. The object in placing them above the ground being to discourage tampering by inquisitive people. Where wires are run in underground conduits, the transformers are often placed in manholes. When this is done special cases are provided, which have rubber gaskets at all openings, thus making the case water tight.

Very large high-voltage transformers are nearly always placed indoors in order to keep them as dry as possible, and also to prevent tampering with them.

Buildings for housing such transformers should be made as fireproof as possible. The transformers themselves should have a draw off valve in the bottom of the case, so arranged that in case of fire the oil can be run off either into the sewer or far enough away from the building to be safe from catching fire.

Connections and Windings

PRACTICALLY all transformers for lighting work and small power purposes have 2 coils in both primary and secondary windings. This enables the transformer to be used for 4 different ratios at its full rated output. The ends of the 2 high-voltage coils are brought to a porcelain terminal block placed on top of the core, as is shown in Figs. 6 and 7. Wires C and D are the ends of one coil, and E and F of the other coil. A and B are the wires which pass out through the case to be connected to the outside circuit. In

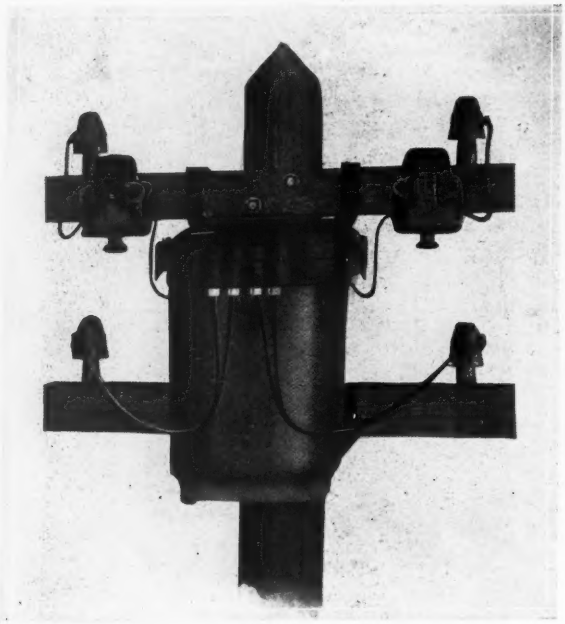


FIG. 5. LIGHTING TRANSFORMER MOUNTED ON POLE

Fig. 6 the 2 coils are connected in parallel and can be connected to an 1100-volt circuit. Figure 7 shows the same coils connected in series so that A and B can be connected to a 2200-volt circuit.

Auto-Transformers

ONE form of the constant potential transformer, called the auto-transformer, has but one coil for both primary and secondary. Such an arrangement for a step-down transformer is shown by diagram in Fig. 10. The supply wires are connected to the ends of the coil 1 and 3, and the receiving circuit to the points 2 and 3, enough turns being included between 2 and 3 to give the desired ratio of transformation. In the diagram shown the ratio of transformation is 2 to 1 and the point 2 is in the middle of the coil.

The auto-transformer has the advantage of being considerably smaller in size for any given capacity than the regular transformer, and is consequently cheaper. It has the disadvantage, however, of having the primary and the secondary in electrical connection, so that it is unsafe to use it on potentials high enough to be dangerous to life. Its chief use is in starting compensators for induction and synchronous motors.

Current transformers are often used in connection with alternating current ammeters for measuring large currents. When designed for this use the ammeter is the only load placed on the secondary, and the primary is placed in the line precisely like an ammeter.

Transformer Faults

THE most common faults arising in the operation of transformers are open circuits, grounds, and short circuits, the last 2 being the result of defective insulation. The coil in which an open circuit has occurred can be located by ringing out the coils with a magneto or with a door bell and battery, but in modern transformers it is of little use to attempt to repair a break inside the coil.

FIGS. 6 AND 7. METHOD OF CONNECTING TRANSFORMER COILS

Short circuits make themselves known by blowing the fuses in the primary side when there is little or no load on the secondary. The coil in which the short circuit occurs can best be located by carefully measuring the resistance of the coils and comparing with each other or with coils of exactly similar transformers, known to be good. As before, a new coil is practically the only remedy.

Grounds between winding and core and case can be determined by use of a voltmeter. Connect one terminal of the supply line to the case and the other to one terminal of the voltmeter. Connect the other terminal of the voltmeter to the different coils in succession. A deflection of the voltmeter indicates a

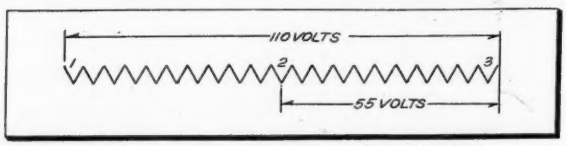


FIG. 8. AUTO-TRANSFORMER CONNECTIONS

ground. Connections between separate coils can be determined in a similar manner. If these connections or grounds be of low resistance they may be determined by a magneto.

If it becomes necessary to determine the temperature of the windings of a transformer by themometer an alcohol thermometer should be used if possible. It is easy to break the bulb of a thermometer in getting it into place or taking it out, and mercury poured into a transformer is liable to cause trouble.

In all transformer work great care should be exercised not to come in contact with the high-voltage winding, as it may easily prove fatal. In handling series transformers never open the secondary circuit when there is current in the primary. While there is practically no voltage on the secondary, so long as the circuit is closed, it rises to enormous values in many cases if the secondary is opened. Failure to observe this precaution has proved fatal to many operators.

PRACTICAL ELECTRICAL ENGINEERING

Magnetic Circuits in Multipolar Machines; Details of Armature and Commutator Construction, the Use of Wedges

SO far we have spoken only of single magnetic circuits. The modern multipolar generator and motor contains 4 or more magnetic circuits, depending upon the number of pole pieces. Figure 1 shows the frame work, poles and armature core of a typical 4-pole generator or motor.

In the completed machine each pole piece is surrounded by a coil of wire called the field winding and forms an electromagnet. By reference to Fig. 1 the path of the magnetic flux set up by the poles will be seen to follow 4 separate paths.

Armatures

ARMATURES of direct-current machines consist of the shaft; the core, built up of thin soft steel or sheet-iron disks, the commutator, and the winding composed of a number of form-wound coils laid in

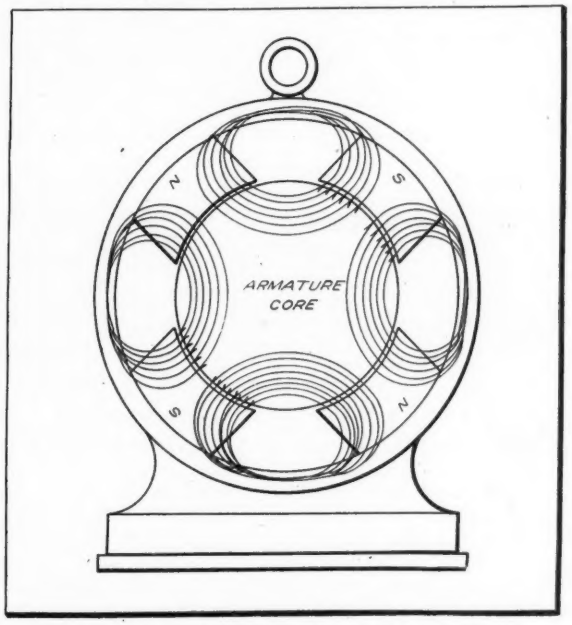


FIG. 1. MAGNETIC CIRCUITS OF A 4-POLE MOTOR OR GENERATOR

slots in the armature core. A form-wound coil is shown in Fig. 2. It consists of several turns of single or double cotton-covered copper magnet wire wound over a form, to secure the desired shape, and then tightly wrapped with linen tape, the completed coil being thoroughly covered with a water-proof compound. The 2 ends of the coil are left free to connect to the proper commutator segments.

Figure 3 shows a diagram end view of an armature with 8 coils. One side of each coil is laid in an armature slot and when all are in place, the other side of each coil is forced into the remaining space in the proper slot. In a 4-pole machine each coil has a pitch of ¼ of the circumference of the armature core, in a 6-pole machine 1/6, etc. In the figure, A and A represent one coil, and B and B a second coil. The commutator segments are numbered 1, 2, 3, 4, etc. In practice a much larger number of coils is used, in order to reduce the potential difference between any 2 segments, generally to 2 to 3 volts, to prevent arcing from one segment to another.

Figure 4 is a connection diagram of common type of winding. In the figure A, B, C and D represent commutator bars and the dotted lines N and S a north and south pole respectively. One lead of the first armature coil is connected to segment A and the other end to segment B, where also is connected one lead to the next coil. Its other lead is connected to segment C, where it joins with the first lead of the third coil and on around the armature.

Commutator

IN Fig. 5 is shown views of a commutator. It consists of a number of wedge-shaped pieces of hard drawn copper, called segments, which are insulated

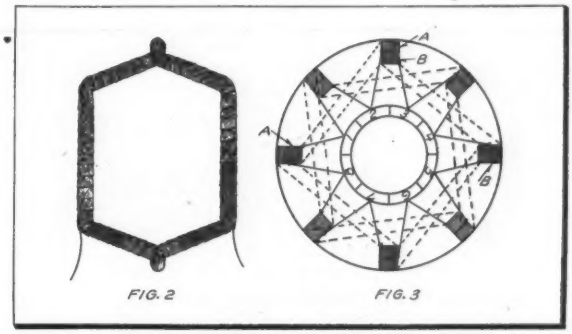


FIG. 2. FORM-WOUND ARMATURE COIL
FIG. 3. SECTIONAL VIEW OF ARMATURE WINDING

from each other by mica. The segments and insulation are held in place by 2 collars forming a complete cylinder on the surface of which the brushes rest.

Retaining Wedges

SOME means must be provided for retaining the armature coils in the slots, as centrifugal force would otherwise cause them to fly out. The method

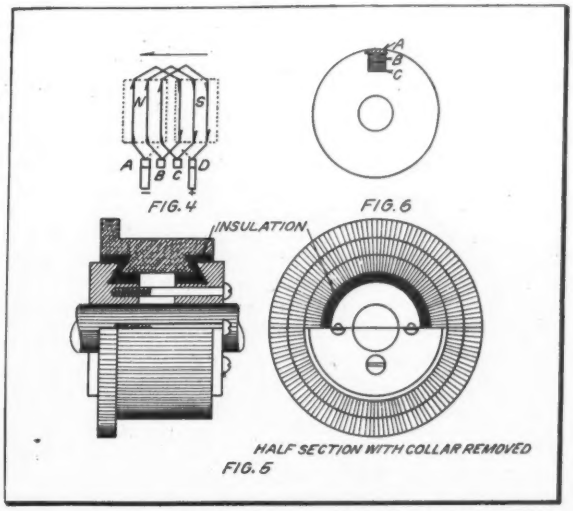


FIG. 4. WINDING DIAGRAM FIG. 5. DETAILS OF COMMUTATOR
FIG. 6. SECTION OF ARMATURE SLOT SHOWING RETAINING WEDGE

in general use today is to employ retaining wedges, driven into V-slots as shown at A in Fig. 6. The 2 coils are shown at B and C.

There are several methods of connecting armature coils to the commutator which will be described in a later article.

Armature Reaction

BEFORE considering the various types of direct-current apparatus it is essential to understand armature reaction which is prevalent in all dynamo-electric machines to a greater or less degree. For a full explanation see an article entitled Commutation in Direct Current Machines on page 615, June 15, 1912, issue of Practical Engineer.

Types of Direct Current Machines

DIRECT current generators and motors vary somewhat in characteristics and are classified according to the service they are to perform. Generators are divided into 3 general classes, series shunt and compound wound; the former type, used so largely for arc lighting in the past is now practically obsolete.

On page 61 of the Jan. 15, 1912, issue of Practical Engineer will be found an article entitled Direct Current Motor and Generator Troubles. This article goes fully into the characteristics of this type of machines.

ELECTRIC ELEVATORS

By A. C. WALDRON

THERE has been so little in print in regard to the care and operation of electric elevators, that I feel some of my experience will be useful as general information. One of the most frequent troubles is poor contact in the electrical end, due to burnt or charred surfaces that are allowed to arc; this can be prevented by sandpapering at least once a day, using 00 sandpaper.

In nearly all electric elevator machines there are carbon brushes which chip and on the contact side will show pitting, which is the direct cause of flashing. Another frequent cause of trouble is the automatic stops at the top and bottom of the well, which cut out the current from the motor. There are 2 kinds for use at the top, and also 2 kinds at the bottom of the shaft. One is attached to the worm gear and is rotated as the car approaches the top or bottom, another is placed at the top of the well about 2 ft. above the position of the car when standing even with the top floor, so that in case the automatic stop attached to the worm gear does not cut out the current, the car will go by the top floor and come in contact with a small lever having a carbon contact which opens and cuts out current from the machine.

The same precaution is necessary at the bottom of the well to prevent the car going on the bumpers, so the cut out attached to the worm gear which was used on the up trip will also act on the bottom of the well, even with the bottom floor. If it does not, the counter-weights will strike against a circuit breaker in the top of the well when the car goes below the bottom floor, and as before cut off all current in the machine; at the same time the brake becomes operative.

Right here is a place for trouble, for if the spring is not given sufficient tension, if the leathers are worn, or if the brake bands get hot due to frequent running, they will not stop the motor and the slippage will sometimes allow the car to go up to the roof or down hard on the bumpers. I have used resin and yellow soap on the brake bands with good effect to stop a sliding brake, or yellow soap if the brake stops too suddenly.

Another thing requiring care is the shoes which run on the guide rails. There are many kinds of linings for car shoes; babbit, in my experience, is the best, although brass, rawhide and hardwood linings are used. The rails should be greased as often as they give warning of scratching, the time depending upon the number of trips a day.

I have found lubricating candles the best and safest. Another source of annoyance is a bouncing car, which is caused by the brake taking hold too quickly, either because the spring is too tight or the leathers are too sticky. A little soap will cure this trouble, or let up on the spring tension. If at times the car will not start, see if the ropes are riding each other on the lifting drum; if they are they will press against the slack cable device under the drum and tip one end down and the other end up and thus break the current.

A spanner wrench, which is made to fit the hub on the brake wheel, should then be used to move the motor until the ropes are in their proper grooves in the drum. Do not attempt to lift the brake weight-arm unless the lifting drum is securely blocked with timber through the spokes. If you do, your elevator will race to the roof, caused by the back drum counter-weights, which are heavier than the balanced car, and were made to balance the average live load.

Look out for the traveling sheave and keep it well oiled, so it will travel and not lag back, causing the ropes to ride over one another as they might run off the sheave and break the back drum counter-weight rope.

TEMPERATURE ERRORS IN WATT-HOUR METER TESTS

WHILE errors of from 2 to 3 per cent in the registration of watt-hour meters are not beyond the limits of commerical accuracy, discrepancies due to temperature may exceed these permissible limits. In d.c. meters, especially those for use on 220 volts and 500 volts, the temperature effect may be responsible for considerable variations from the calibrated values.

Meters brought in from installations for shop test are usually tested at once, before they have had an opportunity to reach constant temperature conditions. But later, when they are checked in service tests, where the potential coils have been continuously energized, discrepancies appear. For this reason, as pointed out by J. A. Whitlow before the Missouri convention recently, some companies have installed load racks in their test shops on which a number of the meters awaiting test are kept connected and partly loaded. Since it is possible to connect all the meters of similar ratings in the same load circuit, the energy loss of such a rack need not be large. In this way, each meter is made ready for test under shop conditions which more closely approach service conditions.—Electrical World.

"SAFETY FIRST" is coming to be recognized as essential in all activity where human life is concerned, and in nearly all such activity, whether for pleasure or profit, buildings are an important part of the equipment. The report of the Building Laws Commission of Illinois, just issued, is based on this consideration. The present pamphlet relates to churches, halls, theaters, schools, colleges, libraries and museums. Later the rules for factories, power houses ,etc., will be issued.

NOVEL ADJUSTABLE SPEED MOTOR

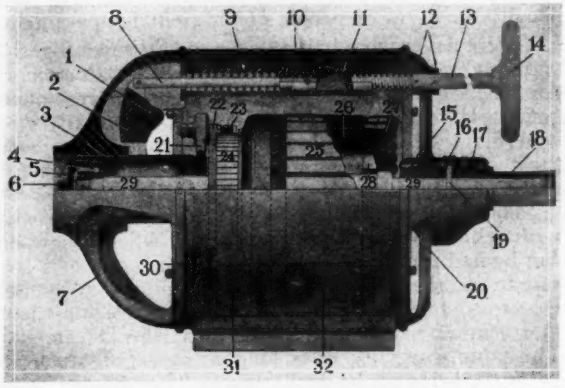
Reliance Motor With Armature and Inner Surfaces of Pole Pieces Having a Slight Taper. Speed Adjustment Obtained by Moving Armature in and Out Parallel With Shaft

IN any motor the speed of the armature varies directly as the voltage impressed across the brushes and inversely both as the number of turns of wire in the armature winding and as the strength of the magnetic field within which the armature rotates. Any adjustable speed motor, therefore, must operate by producing variations in one or more of these 3 factors.

It is impracticable to vary the number of turns of the armature winding. The Reliance adjustable speed motor operates by producing a gradual, smooth, and continuous variation in the strength of the magnetic field within which the armature rotates, resulting in a similar variation in speed.

Strength of a magnetic field varies directly as the strength of the field coils energizing the iron or steel and inversely as the magnetic reluctance of the magnetic circuit. The magnetic reluctance of a magnetic circuit corresponds to the resistance of an electric circuit. Lines of magnetism traverse air with great difficulty, iron very easily, and steel still more readily.

In a motor, the magnetic circuit, or path followed by the lines of magnetism, starts in a field pole, crosses the air-gap to the armature, traverses the armature to the next pole piece, again crosses the air-gap,



CROSS-SECTION OF RELIANCE MOTOR SHOWING PRINCIPAL PARTS

and returns by the second pole piece and motor frame to its starting point. By far the greatest part of the magnetic reluctance of this entire circuit is at the air-gap, and any change in the length or area of the air-gap produces almost proportionate changes in the strength of the magnetic field within which the armature rotates and consequently in the speed.

In a Reliance adjustable speed motor, both the armature and the inner faces of the pole pieces are given a slight taper. Both represent surfaces of truncated cones, one within the other, with the shaft as the axis. Any lateral movement of either parallel with the shaft increases or decreases the distance between the 2 surfaces corresponding with the air-gap. The normal position of the armature is directly beneath the pole pieces, and in this position the air-gap is a minimum. Gradually withdrawing the armature laterally, not only gradually increases the length of the air-gap, but also decreases its area; that is, the area of the air-gap no longer corresponds with the total area of the inner face of each pole piece, but with the decreased area now lapping the armature. Both effects produce a gradual increase in the magnetic reluctance, a gradual decrease in the strength of the magnetic field within which the armature rotates, and a gradual increase in speed. On account of the cone-shaped form of the armature and pole pieces, only a slight lateral movement is required to produce wide ranges in speed, even as high as one-to-ten.

The accompanying illustration shows a cross-sectional view of the Reliance motor giving details of the principal parts; the table below is a key to the numbers. Reliance Electric & Engineering Company, Cleveland, O., is the manufacturer.

1. Lever Fulcrum Pin.
2. Lever.
3. Sliding Thrust Bearing Box.
4. Ball Bearing.
5. Armature Shaft End Nut.
6. Cap.
7. Commutator End Yoke.
8. Lever Rod.
9. Compression Spring.
10. Steel Frame.
11. Speed Adjustment Nut.
12. Thrust Collars and Pins.
13. Hand Wheel Rod.
14. Hand Wheel.
15. Sleeve Nut.
16. Oil Well Cover.
17. Bearing Bushing.
18. Sleeve.
19. Oil Ring.
20. Pinion End Yoke.
21. Rocker Arm.
22. Brush Holder Stud.
23. Brush.
24. Commutator.
25. Armature.
26. Armature Laminations.
27. Armature Coils.
28. Armature End Plate.
29. Armature Shaft.
30. Leads.
31. Axial Position of Commutating Pole.
32. Axial Position of Main Field Pole.

SHIP PROPULSION BY DIESEL ENGINES is making rapid progress abroad, the German yards having some 8 or 9 vessels of considerable size on the ways at the present time. The advantages of such vessels are twofold. First, the smaller space occupied by the fuel and the engine equipment as compared with steam propulsion gives greater cargo capacity for a vessel of given dimensions, and secondly, the fuel bill is considerably less.

Calculations of the cargo capacity of 3 large ships driven by Diesel engines indicate advantages of 15 to 18 per cent as compared with steam propulsion. Figures as to fuel consumption indicate that the oil weighs between 1/3 and ¼ of the coal required for similar service with steam engines. The first vessel of this type to visit the U. S. called in New York recently. The vessel, the "Christian X," of the Hamburg-American Line, is 370 ft. long, of 53-ft. beam and has a carrying capacity of 7400 tons.—Engineering Record.

CORRESPONDENCE OF AN OLD ENGINEER AND HIS SON

Making an Educated Guess

MY DEAR SON DONNY:

It is raining quite hard this afternoon and as I cannot take my customary stroll, I will try to answer your letter of the 6th, which came to hand in due season and we were both very glad to hear from you again.

I do not expect to write much this time, as my rheumatism is bothering again. Perhaps it is because I helped mother do the washing yesterday. Washing always has been a little out of my line and don't suppose that I will ever learn the trade.

We are both glad to get your letters and to read your experiences in bucking up against the world at large with the object in view of learning more and earning more. If I remember well, I think that I advised you in the first letter that I wrote you after graduating from Tech (is that what you call it?) to forget that you had an education that most boys don't have, and to go out and "get experience."

Now, son, while I am sorry that you let go of the firing job, in one way, yet I am glad in another, especially as you say that you have been transferred to the "repair gang." If there is any place in this world where a fellow will get the corners rounded off—yes, knocked off—more than another, that place is the repair gang.

The repair gang is where you do get experience with a big "E." If a man makes good on the repair gang, he can make good almost any place within the limits of his natural inclinations. There are so many different things to do and the variety is unlimited. The jobs are like the old calling cards we had 30 or 40 years ago,—"50 for 10 cents, no two alike." There are no two repair jobs just the same.

If you get a broken line shaft all fixed up running, and the word comes that another one has been twisted off, there are many things about the second shaft which were lacking in the first one. And you have to keep your wits about you all the time so as not to have to undo something so as to put in some bolt or key or perhaps a set collar which had been forgotten.

That reminds me of a fellow back in the old days who had ambitions above that of skittering up and down the "Point" division with a little Baldwin standard held on to the front end of the way freight by an old link and pin. One of his ambitions was to run on "lap orders." Another was to drink 40 rod whiskey and still another was to do something else besides railroading it.

When he got about a dozen or so under his jumper, he had a natural penchant to run past his "meeting points" to at least the next station, if he had to pull out every drawbar on the train. One day he realized all 3 of his ambitions at once; he didn't quite make the next station on account of there being another train that was using the track just then.

When he came to, he had gratified all 3 of his ambitions for the M. M. told him that he could take 30 days a month vacation 12 times a year. So he went over to Blatzville to a tannery and got on the repair gang. Right there he got several big chunks knocked off which go under the head of experience.

After he had been there but a few days the boss came to him and told him that the box on the east side of the main pulley on the main line shaft had to be babbitted and asked him if he could do it. Could he? Why, he did that every morning to work up an appetite for breakfast. Sure he could do it. And he did,—almost.

The shaft was about a 5-in. and the boxes were the ordinary old style boxes with upper and lower halves. He melted the old babbitt out and put the boxes back on the job with liners in all right, but here is where he forgot something. He neglected to arrange for the metal to run through into the lower half by means of cutting notches in the liners and placing them up against the shaft.

He placed the liners about half an inch from the shaft so that there would be no obstruction for the molten metal. Then he forgot to smear some magoozlum on the shaft. He babbitted the bearing all right. Not only that, but he soldered it to the shaft, and worse still, he had no way to split the box again.

Now, when you do a job, take good care that you do not have to undo something before you get through. Sometimes it costs more to undo a job than it does to do it in the first place.

And here is another thing that you will have to contend against, my son. In a shop of the size that I judge yours to be by the description in your several letters, the repair gang must be quite a feature. It is usually made up of people of different temperaments.

There never were half a dozen men thrown together on a job of any kind yet but that there is "an anchor." An "anchor" is a man who is a drag on the rest of the gang. His stock in trade consists principally of a superfluity of gab and a chronic inclination to want the tools that someone else is using in preference to getting some of his own.

This kind of a fellow will fool around for a week with a broken handle in his hammer when a new one can be had for the asking at the stock room. As soon as one of the other fellows comes around the "anchor" is sure to ask: "Say, old man, let me use your hammer a minute, will you? Mine has a broken handle." The minute usually is as long as a wagon track and he never brings it back till you go after it, and he has the gall then to say, "I was just going to bring it back."

The "anchor" never looks up his own wrenches, tools and incidental stuff. He always goes around where someone else is working and gets them without looking. And if the owner is not around, so much the better—for him. This is the kind of a fellow who always sidles up to the boss and glibly tells him how he (the anchor nuisance) arrived on the job with the proper tools, just in time to save it.

Now, Donny, I do not know whether you have an "anchor" on the job or not, but if you haven't, you soon will have. This kind of a fellow is just as sure to turn up as a book agent, or the assessor.

The best way to do with him is to sit right down on him the first thing. You will get the reputation for a few weeks of being an all-around grouch—but it will save you a lot of time running around after your tools, and perhaps the price of some of them, too. In the due course of human events, this kind of a fellow gets transferred to the "waiting list" sooner or later. This is "the anchor" as we used to call them years ago. Today, however, I understand that they are called "windy."

Well, perhaps this is enough of this kind of sermonizing. You will find many interesting experiences on the repair gang. You want to learn how to calculate, mentally, if possible, weights, measurements, distances, sizes, and other things. Suppose you had a smokestack to raise that was 24 in. in diameter and was made up of 16 sections, each 4 ft. long and ⅛ in. thick.

It is easy to calculate as you look at it, about as follows: "Two feet in diameter means about 6 ft. in circumference, and 6 × 4 is 24 sq. ft.,—well, call it 25. Then a square foot of sheet iron or steel weighs about 5 lb., and 5 × 25 is 125 lb. per section. As there are 16 sections, then, if it only weighed 100 lb. per section, the whole stack would weigh 1600 lb. But it weighs one and a fourth hundred, per section, therefore the total weight must be one and a fourth times 1600, or 2000 lb."

See how easy it is, Donald? In a case of this kind, that is close enough for all purposes, only add, say, a couple of hundred or so for the guy wire, guy bands, damper, and also to be on the safe side.

You must also learn to know when to stop, or, in other words, know when a thing is good enough and that to make it any better would be a waste of time—and time is money, you know. When you are making a wedge with which to level up a bulldozer, or a steam hammer, if you get within an eighth of an inch, that is good enough. But if you are going to turn out a new crank disk, with a taper press fit—and to calculate the pressure required to put it on with—then a thousandth of an inch is a long ways, while two-thousandths is a misfit.

You need "horse sense" on the repair gang if you ever needed it at all. If you are going to set a small duplex pump to feed the boilers, it must be set on a solid foundation, just the same as an engine. But if you are going to use it to pump out a pit, or the basements under the new addition to the factory, screw it to a 3-in. plank with some bolts and see that it doesn't tip clear over.

Then there is a lot to be learned about belting and shafting, for you will likely have a lot of both to attend to. Of course, the boss is supposed to do all the thinking for the repair gang, but he got the job himself because he was found to be competent to take it when there was a vacancy. Some day there will be another opening some place and if there isn't, you ought to know these things anyway, if you are ever going to be an engineer.

Any one can do a job of any kind if he cuts and fits enough,—and the material holds out. I saw a fellow in a little planing mill once who didn't know how to figure out pulleys and when he went to get a pulley to run the new re-saw, he sort of guessed at it. When he started up he had a good sized cyclone on his hands.

In calculating shafting be sure that you are on the safe side—and then add a little. Nobody sticks absolutely to figures as they stand, except theorists, who don't know any better. Same way with belting. If it wasn't for the rolls of belting that are ruined trying to make it stay on the pulleys and pull the load when it isn't half big enough, the belting concerns would go bankrupt.

Sawing planks and iron pipe in two with the edge of a belt has knocked a hole in the bottom of more than one profit and loss account. And another thing: Look at the concerns that are prospering in your vicinity and of whom every employe speaks a good word, you never see a belt in their works that has to be held on the pulley by the side of a board.

It doesn't take very many "fixin's" on a belt, to pay the additional cost of a belt and pulley a little larger and which would do the work twice as long without "fixin'." The watchword of the repair gang should be, "TIME IS MONEY." I have seen a fellow spend 2 hours making 6 quarter-inch nipples and making a nipple holder to hold them in, when they could be bought at a store not 2 blocks away at a nickel apiece while he got 30 cents an hour.

Well, my son, I forgot all about my rheumatism, I got so interested in writing, until mother announced that supper was ready. I am sorry that she called me, for I was just getting nicely wound up. We are going to make some mincemeat tonight—that is, we're going to peel the apples for some.

I wanted to say a lot more and comment on your last letter, but it will have to keep till another time. You asked about Jerry Smith. Yes, that is the same Jerry Smith of Lisbon Co., and one that used to run for coroner nearly all the time. Mother sends her love and says to tell you to be a good boy.

Affectionately your father,

Sandy MacDougal.

P. S. Did you start in to measure pipe on the outside, and put the ½-in. fittings in the ¾ bin?

S. MacD.

THE OCEAN MOTOR

Another Means for Utilizing Nature's Power Employing Gravity and Velocity Pressure

WAVE motor versus the ocean motor, wherein lies the difference? Is the latter just a new guise for a little variation in type of the former, to withdraw public attention (and possibly dollars) from the one and attract them to the other; or is the ocean motor one which really does not depend upon wave motion for its power?

At many seaside resorts we have been treated to numerous demonstrations of the wave motor; on the breakwater pier at Venice, near Los Angeles, Cal., we

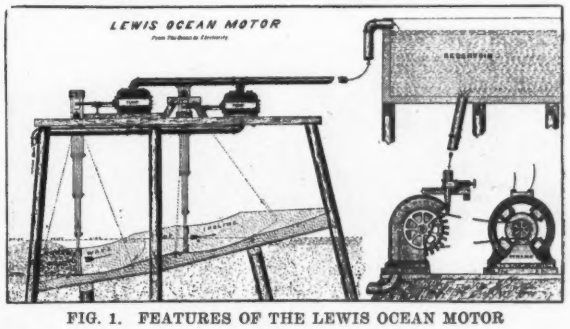


FIG. 1. FEATURES OF THE LEWIS OCEAN MOTOR

were shown a working model of the Lewis Ocean motor, particularly stated as not a wave motor. The real commercialism of this ocean motor rests somewhat in the reader's judgment.

In explaining its invention, the company states that former attempts to harness the ocean have been along only 2 lines, float motors and pendant motors. The first, consisting of various forms of floats, depends upon the rise and fall of the water, as the wave passes, for power. The power to be derived equals the buoyancy of the float multiplied by its travel per minute.

The larger the float, the greater its buoyancy but less the travel, showing that the scope is limited.

The pendant motor consists of a paddle hung in the water to employ the oscillatory motion of the wave as it passes. The power obtained is equal to the pressure per square foot multiplied by the area of impact surface, multiplied by the travel per minute. The back and forth motion, being greatest at the surface and decreasing to zero at the axis, affords too little travel to make this type of motor a success; the up and down motion, through the same cause, likewise limits the possibilities of the float motor.

The Lewis Ocean Motor is so named because it does not derive its power from the waves, being entirely dependent upon flowing water. It embodies the principle of the simple lever, employing gravity as the essential element. The patent office records, we are informed, show this to be the first and only motor using gravity as the primary principle, the basic patent being an incline plane.

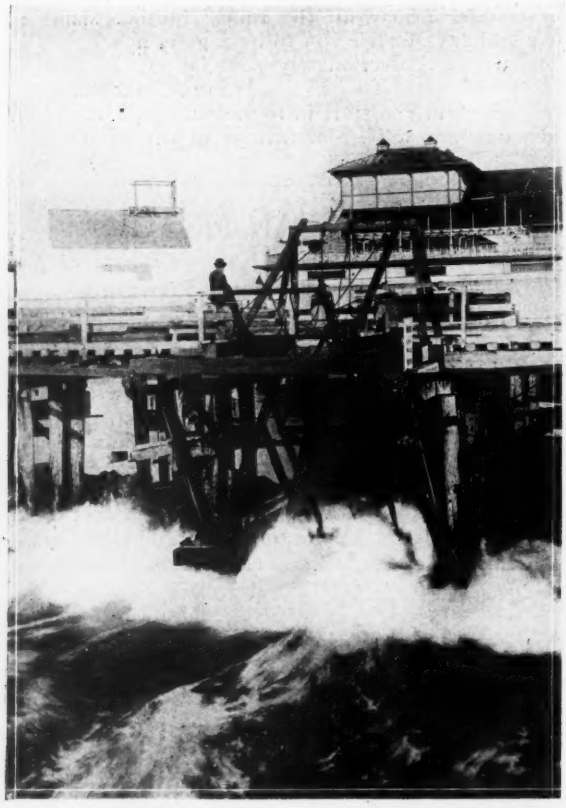


FIG. 2. EXPERIMENTAL PLANT USING LEWIS OCEAN MOTORS

The features of the Lewis motor are shown in Fig. 1. An inclined structure, or floor, is built in the form of a series of troughs. The concrete plane rests on wood piling with a sand fill. Division walls, 4 ft. high and 16 ft. apart are placed upon the face of the incline, between which wood vanes or paddles operate. These vanes are 16 ft. wide, to suit the trough width, by about 24 ft. high; being pivoted from the top of the wharf structure, they operate with a pendulum action, describing 24-ft. arcs. The concave portion of the incline conforms with the swing of the vanes, which are constructed of 2 by 12-in. planks bolted together in the manner indicated. The vanes are direct-connected to pumps located on the wharf; these operate a main supply line to a storage reservoir, from which point, gravity flow actuates a waterwheel.

The seaward end of the incline is buried in the bed of the ocean so that the point A on the arc of the lower vane is at zero tide line, and the back end of the plane projects above the high tide crest line. The oscillatory motion of the ocean swell over-balances the water, whereupon tending to seek its level, it flows over the incline in the form of a river. The velocity causes it to flow to a point on the incline higher than the crest of the swell. The adjacent trough causes the ocean to lower before the incline, forcing the water on the incline to again seek its level and flow back over the trough plane. The ocean is thus formed into a sort of river, flowing back and forth over this structure.

The impact member of the vane is 4 ft. high, completely effecting a dam for the trough, and allowing no water to pass without moving the vane. When the vane reaches A or B, C or D, the pump load is released so that the water may flow freely past the vane. On the return stroke, the vanes again dam the trough, resisting the water on one side, and allowing the water on the other to flow freely into the trough of the ocean.

As seawater weighs 64 lb. per cu. ft., the pressure against the 4-ft. dam would average about 128 lb. per square foot area. Such pressure plus the pressure due to the velocity, is the pressure assumed on each square foot of vane; this multiplied by the travel of the vanes gives the initial force.

Early in 1911 the experimental plant, Fig. 2, was placed under a 35 days' test, hourly readings being taken to determine the average travel of the vane. Under the conditions of such plant, this was found to be 94.5 ft. per minute; during the period the vane was under load and proved a value of 12 hp. from the velocity pressure alone, per unit of 64 sq. ft. impact surface. It is estimated that the present plant as described, now nearing completion, will net 20 hp. per unit, allowing 2 vanes to equal one and providing for a factor of safety in the calculations.

Again the reader's imagination must be somewhat brought into play by considering the following estimates of cost, made by the company at the solicitation of the writer: A 100 unit plan, of 20 hp. per unit or 2000 hp. total, at an initial cost of $200 per hp. would aggregate $400,000. A steam plant at $50 per hp. is estimated at $100,000 for the same capacity; such plant, including interest on investment, labor, fuel, maintenance, etc., for one year is estimated to cost $130,000. The only cost of the ocean motor plant is the interest on the investment, or at 6 per cent, $24,000, with a resulting saving of $106,000 or 26½ per cent in 12 months.

Which sounds very good, but what about depreciation and maintenance, especially in case of a hurricane?

NEW COPPER STRIKE

IT is reported in Phoenix, Ariz., that a huge copper strike has been made recently near the Kay and Harris copper mines. The reports are that the strike is the largest ever made in Arizona. The strike is said to have been made about 2 months ago, near the mouth of Black Canyon Creek, 50 miles north of Phoenix, where it enters into the Agua Fria. Mining men from all over the country have been traveling through Phoenix to that vicinity incessantly for the past month or two.

AMMONIA COMPRESSORS*

Influence of Suction Pressure on the Refrigeration Capacity of the Compression and the Power Required to Operate It

By Robert N. Karl

AMMONIA compressors are constructed to take in ammonia gas at a low pressure and temperature and discharge it at a higher pressure and temperature, and piston displacement, is the measure of refrigeration capacity.

If we speak of an ice machine of so many tons of refrigeration, it relates to the piston displacement, per minute, of the compressor, not to the refrigeration actually given for a 50-ton machine may produce only 30 tons of refrigeration under certain conditions, while under most favorable conditions, it may produce 70 tons.

With an ice machine the question is, "Under what pressures is a ton of refrigeration to be produced?" If a compressor discharges a certain number of cubic feet of ammonia gas with the least expenditure of work, that is all the machine can do, and its efficiency depends on the pressure of the gas entering the compressor, and the pressure against which the gas must be discharged.

A pound of ammonia can either absorb or give off a certain amount of heat by changing its aggregate state, i. e., from a liquid to a gas or from a gas to a liquid, and since a cubic foot of ammonia gas increases in weight when its pressure increases, it is evident that more refrigeration can be performed, if the incoming gas is of high pressure and since the amount of work that must be expended depends on the pressure against which the gas is discharged, the lower this pressure is, the less work is required. In other words, the nearer the 2 pressures can be kept together in operation, the greater the capacity and economy.

Both pressures are governed by attendant conditions, that is, temperature of the refrigerator and the pipe surface in one case, and pipe surface, temperature and quantity of cooling water in the other case. These conditions which govern the capacity and economy should have proper consideration when the plant is installed, and because this is seldom the case many refrigerating plants are impaired in capacity and economy. Sometimes for the sake of a few dollars worth of piping surface, the entire plant is crippled, while on the other hand the compressor is bought entirely too large or too small for the work it has to do and money is thrown away in this direction.

Rule for Compressor Capacity

LET us see how the suction pressure of an ammonia compression machine, that is, the pressure of the gas as it passes from the cooling coils to the compressor cylinder, exerts such a marked influence upon the capacity and also upon economy of the refrigerating machine. We will first consider the rule for theoretical capacity, which is:

Ice melting capacity=0.00505×strokes per minute × pounds of ammonia per stroke × (latent heat at temperature of freezing coils — temperature in condenser + temperature in freezing coils), or as a formula: F=0.00505 NW (l—Tc+Cf)

in which, F=Ice melting capacity; N=No. of strokes per minute; W=Weight of ammonia per stroke; l=Latent heat just before evaporation; Tc=Temperature in condenser; Tf=Temperature in freezing coils; 0.00505=A constant.

Since the number of strokes remains constant, it is evident that the capacity depends upon the weight of ammonia, latent heat at time of evaporation (practically suction pressure), the temperature in the condenser and the temperature in the freezing coils.

Referring to the table of properties of ammonia, it is seen that as the suction pressure is increased, the corresponding latent heat becomes less, and the corresponding temperature rises; consequently the sum of latent heat and temperature in freezing coils changes but little with different suction pressures, and the capacity is practically proportional to the weight of ammonia circulated.

Take for instance, a suction pressure of 18.45 lb.; the weight of a cubic foot of gas at that pressure is 0.069 lb., while at a pressure of 38.55 lb. a cubic foot weighs 0.1384 lb. or twice as much; and as the same volume of ammonia gas passes through the compressor in a given time, no matter what the pressure is, the weight of the ammonia gas circulated is proportional to the weight of the vapor per cubic foot. Then with the greater suction pressure, the machine will circulate double the weight of ammonia that it will with the lower pressure and the capacity at the higher suction pressure will be nearly double that at the lower pressure.

It requires more power to operate the compressor at a higher suction pressure, but the increase in power is not porportional to the increase in capacity because the ratio of the power consumed to the capacity, decreases as the suction pressure is raised. The power is proportional to the heat delivered to the condenser minus the heat taken from the cold body, and the capacity is proportional to the heat taken from the cold body, therefore the ratio,

$$\left\{\frac{\text{Horsepower}}{\text{Ice melting capacity}}\right\} \text{ is proportional to the } \left\{\frac{\text{Heat delivered to the condenser—heat taken from the body cooled}}{\text{Heat taken from body cooled}}\right\}$$

The only effect on the heat delivered to the condenser of raising the suction pressure is to lower the temperature at the end of compression. The only effect on the heat taken from the body cooled is to decrease the latent heat of the liquid just before vaporization and increase the temperature in the freezing coils; but the temperature in the freezing coils increases faster than the latent heat before vaporization decreases, so that the net effect of raising the suction pressure is to increase the heat taken from the cold body.

Since the heat delivered to the condenser is decreased and the heat taken from the body is increased the ratio of power to ice melting capacity is decreased by raising the suction pressure; therefore, we have the important fact that increasing the suction pressure, increases both the capacity and economy of the machine.

Figuring Capacity for Different Pressures

THE few examples following will perhaps serve to make things a little clearer. Take a so-called 50-ton compressor, that works without superheating; 12

*A paper before the Institute of Operating Engineers.

in. diameter and 24 in. stroke, double acting, at 70 r.p.m. and 80 per cent volume efficiency. If this compressor works with a suction pressure of 10.31 lb. (temperature — 8 deg. F.) against a condenser pressure of 200 lb. gage pressure (temperature 100 deg. F.) each cubic foot of ammonia gas at 10.31 lb. of pressure would weigh 0.0921 lb., and each stroke of the piston displaces 1.57 cu. ft. of gas, the weight of which at that pressure would be 0.1445 lb. and the example would read like this:

Case 1. Capacity = $0.00505 \times 70 \times 2 \times 0.1446$ (560.39 —100—8) $\times 0.80 = 37$ tons; and the horsepower would be about 76.2; so that this machine would fall short about 13 tons of the supposed capacity. If the same compressor is operated with a suction pressure of 27.28 lb. and a condenser pressure of 170 lb., the weight of the ammonia discharged per stroke would be 0.2366 lb. and at the same speed would give this compressor a capacity of:

Case 2. Capacity = $0.00505 \times 70 \times 2 \times 0.2366$ (546.88— $91+14) \times 0.80 = 62.88$ tons, and the horsepower would be about 83.2.

This example shows the foolishness of buying a machine of 50 tons capacity without knowing under what conditions it will have to work, for this compressor will develop its rated capacity, only with a suction pressure of 18.68 lb., and a condenser pressure of 180 lb. at the same speed and same efficiency, and the example will read like this:

Case 3. Capacity = $0.00505 \times 70 \times 2 \times 0.1903$ (553.04— $94+4) \times 0.80 = 49.81$ tons and the horsepower would be about 80.4.

The same compressor may, however, produce a great deal more. In the case of wort cooling in a brewery where the suction pressure was 44.72 lb. and the condenser pressure is 180.43 lb., the weight of ammonia discharged per stroke is 0.3295 and the formula would give:

Case 4. Capacity = $0.00505 \times 70 \times 2 \times 0.3295$ (536.91— $94+30) \times 0.80 = 88.15$ tons and the horsepower would be about 91.2.

Comparisons

FROM the above examples it is seen that increasing the suction pressure gives a marked difference in capacity from the same machine at the same speed and efficiency. Take for instance Case 3 where the compressor is working at its rated capacity doing 50 tons of refrigeration with about 1.6 hp. per ton and compare it with Case 1 where the same machine at the same speed, working at a lower suction pressure, and 2 hp. per ton; it is seen that the capacity is reduced 26 per cent, while the horsepower per ton is increased 25 per cent.

Now compare Case 3 with Case 2, where it is seen that increasing the suction pressure from 18.68 lb. to 27.28 lb. resulted in increasing the capacity of the compressor to 62.88 tons or practically 12 tons increase or 26 per cent, while the horsepower per ton has been decreased from 1.6 to 1.24 or about 22½ per cent less power per ton.

In comparing Case 2 with Case 1 we find that raising the suction pressure from 10.31 lb. to 27.18 lb. resulted in increasing the capacity of the compressor 70 per cent and power requirements only 9 per cent. In other words the extra 25.8 tons refrigeration was obtained at an expenditure of only 7 hp.

Efficiency of 80 per cent was assumed which agrees closely with results obtained in practical tests, in some cases more and in some cases less, depending upon how well the machine is designed and operated and the skill of the operator in keeping the machine in first class condition. The principal and unavoidable losses are self-reduction of the liquid and suction depression, the other losses are in superheating, leaking of piston and valves, and excessive clearance, and can be reduced to a minimum.

In the above examples 20 per cent was added to the theoretical horsepower to make up for losses of friction, etc.

Operate your machine with as high a suction pressure and low a head pressure as possible to keep your required temperatures and make use of your indicator and learn to analyze the cards and you will be surprised at the defects it can show you. An indicator card taken from an ammonia compressor tells of the work preformed by the machine. In analyzing the card, by comparing the compression curve with the isothermal and adiabatic curves, it shows excessive clearance and re-expansion losses, leaky or defective valves and piston, and calculations can be made which will show the extent of these losses. All of these items are important if the machine is to be operated at its fullest efficiency, and the indicator should therefore be used frequently on an ice machine, as it tells immediately if there is anything wrong with the compressor or with the system in general. It is not necessary to make more exhaustive and expensive tests on an ice machine, as the simple indicator card tells the work of it in full.

Discussion by H. E. Geare

THE ammonia compressor is a vapor pump pure and simple; its function being to draw the expanded ammonia gas from the expansion coils and deliver it to the condenser, where it is cooled by water. All gases are heated by compression, the amount of heat generated in the cylinder depending on the amount of work done by the piston in compressing the gas. It is necessary to keep this heat as low as possible, because it affects the capacity of the compressor, this loss from heating sometimes amounting to from 10 to 15 per cent, as the capacity depends entirely on the number of pounds of ammonia the compressor can draw from the expansion coils a minute, it is evident that the more we reduce the weight of a cubic foot of expanded ammonia, the more the capacity of the compressor will be reduced.

All gases increase in volume as the pressure upon them is reduced, and in almost direct proportion to the reduction in pressure; that is to say, 1 cu. ft. of gas at 30 lb. absolute, will occupy a space of ½ cu. ft. if pressure is increased to 60 lb. absolute.

As the latent heat of ice is 142 B.t.u., and one ton of refrigeration is the amount of heat that must be extracted from 2000 lb. of water at 32 deg. F. to make it into 2000 lb. of ice at 32 deg. F., the heat extracted per ton refrigeration is, $2000 \times 142 = 284{,}000$ B.t.u., which if extracted in 24 hr. gives 197.5 B.t.u. per minute.

The exact size of a compressor cylinder for any given refrigeration capacity, cannot be given unless the temperature to be maintained is known, also the head or condenser pressure that is expected to be maintained.

Calculating Compressor Capacity

HAVING these data, the piston displacement required is found as follows:

At condenser pressure of 185 lb. gage and suction pressure 15 lb., the corresponding temperatures from

the table of properties of ammonia are about 95 and —1 deg F. respectively, and heat of vaporization at 15 lb. is 556 B.t.u.

When the ammonia expands, some of the latent heat taken up during expansion is that released by the drop in temperature of the ammonia itself from 95 deg. to —1 deg., and allowing roughly that 1 B.t.u. is extracted in lowering 1 lb. of ammonia 1 deg., the 1 lb. will give up 95—(—1)×1=96 B.t.u.; so that the heat absorbed from outside will be 556—96=460 B.t.u. for each pound of ammonia expanding.

For a ton refrigeration capacity,—197.5 B.t.u. a min., there will be required 197.5÷460=0.428 lb. ammonia a minute to be circulated. The table gives the volume of 1 lb. ammonia at 15 lb. pressure as 9.23 cu. ft., so that the piston displacement per minute for 1 ton refrigeration will be 0.428×9.23=3.96 cu. ft. net at 100 per cent. At 70 per cent of nominal displacement, this would require 3.96÷0.70=5.66 cu. ft. per actual ton refrigeration.

Similarly for 185 lb. condenser and 30 lb. suction pressure the figures will be: 197.5÷[545—(95—17)]×6.22=2.63 cu. ft. displacement per actual ton refrigeration, so that the gain in capacity due to rise in suction pressure is (3.96—2.63)÷3.96=0.336 or 33.6 per cent. Allowing 10 deg. between ammonia and refrigeration temperatures, 15 lb. suction will give 9 deg. refrigeration temperature and 30 lb. will give 27 deg.

In like manner for the cases given by Mr. Karl the net, 100 per cent, displacement for a ton refrigeration would be:

Head pressure 200 lb. Suction 10 lb.....4.75 cu. ft.
Head pressure 168 lb. Suction 28 lb.....2.74 cu. ft.
Head pressure 168 lb. Suction 20 lb.....2.92 cu. ft.
Head pressure 185 lb. Suction 45 lb.....1.95 cu. ft.

Having the net displacement per ton, the rule for tons capacity of refrigeration for any double acting compressor is: Capacity=(0.7854×diam.^{2}×stroke×2×r.p.m×0.70)÷(1728×required net cu. ft. displacement per min. per ton for given condenser and suction pressures); or as a formula:

$$C=(0.000637\times D^2\times L\times N)\div V$$

where C=tons capacity; D=diameter in in.; L=stroke in in.; N=rev. per min.; V=required net cu. ft. displacement per min. per ton.

As Mr. Karl has not given us the derivation of the constant 0.00505 appearing in his formula, I have recalculated his 4 cases of refrigerating capacity of a 12 by 24-in. double-acting compressor operating at 70 r.p.m., using round numbers, and 80 per cent of nominal displacement, instead of 70 per cent which changes the constant from 0.000637 to 0.000728.

Case I—0.000728×12^2×24×70÷4.75=37 tons.
Case II—37×4.75÷2.74=64.1 tons.
Case III—37×4.75÷3.52=50.1 tons.
Case IV—37×4.75÷1.95=90.2 tons.

Comparison will show substantial agreement with Mr. Karl's figures.

For handling ammonia compressors to the best advantage the following general rules should be observed:

Carry as low condenser pressure as possible and as high expansion pressure as can be maintained, the temperature of your cooling rooms considered. Remember, the lower the head pressure, the less the load will be on the engine and the less fuel will be required. The less the difference between the head pressure and expansion pressure, the more economically will the plant be run.

Study the boiling points of ammonia and carry an expansion pressure so that its boiling point of ammonia will be about 10 deg. F. below the room temperature you wish to maintain.

If water has to be bought, balance the cost of water against the cost of coal. Water always costs something, if it is only the cost of pumping.

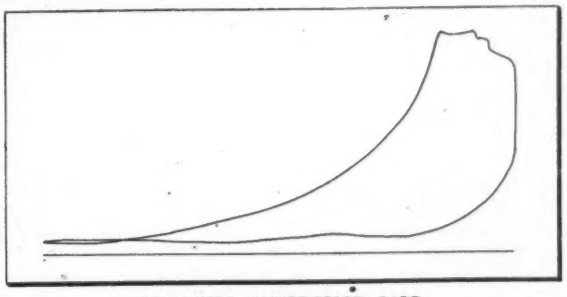
As the temperature of cooling water is never the same in any 2 plants, the amount of piping in the atmospheric condenser must be proportioned to suit the local conditions. The amount of 2-in. piping used per ton of refrigeration with water temperatures between 50 deg. F. and 85 deg. F. varies from 30 to 60 lineal ft. The amount of water required per minute per ton of refrigeration, at temperatures from 50 deg. F. to 85 deg. F. varies from ¾ to 2½ gal. a minute. These quantities are based on water leaving the condenser at about 90 deg. F.

PROBLEMS MET IN REFRIGERATION PLANTS

STATE any defects shown on the diagram and give causes. (It is a compressor diagram.)

2. An ammonia compression machine, running at 60 r.p.m., has 2 single-acting cylinders 8 in. in diameter with a stroke of 12 in. The condenser pressure is 170 lb. per sq. in. gage, the suction pressure 20 lb. per sq. in. gage, and the slip 20 per cent. The cooling water is delivered to the condenser at a temperature of 65 deg. and leaves at a temperature of 80 deg. How much cooling water will be required per hour?

3. The brine coils of a cold-storage room are to be supplied from a main 150 ft. long that is to be erected at a temperature of 75 deg., and the brine is



AMMONIA COMPRESSOR CARD

to be circulated at a temperature of 0 deg. What allowance must be made for the contraction of the main?

4. A cold-storage plant requires the circulation of 500 gal. of brine per minute against a head pressure of 15 lb. per sq. in. If the piston speed is 50 ft. per minute, the ratio of piston diameter to stroke is 1⅓ to 1, and an allowance of 15 per cent is made for slip. What must be the dimensions of the pump cylinders of a duplex brine pump for the plant?

5. With steam at 80 lb. gage pressure following full stroke, and an allowance of 10 per cent for frictional resistances, what must be the diameter of the steam cylinders in question 4?

A. In the first place the card on the compressor which you show is somewhat hard to distinguish on account of the coarse lines from the carbon. As near as we can determine from it, there are the following faults:

There seems to be a loop at the toe on the left-hand end, showing that the pressure in the cylinder drops below that of suction. This is a peculiar condition, and the only explanation we can give of it is leakage past the rod of the compressor into the air. I should suppose, however, that so bad a leak as is shown on your card would make itself evident by the ammonia in the air.

You do not say whether the machine is a dry or wet machine, but I take it from the appearance of the compression curve that it is a wet machine, and for that the compression curve is reasonably good. There is, however, during the discharge line at the top of the card, a very considerable falling off in pressure, which would indicate that the discharge valves opened hard or else are mechanically opened and do not open so soon as they should. There will be a slight drop just after opening of the discharge valve, but after that the discharge line should be horizontal, whereas in the case of your diagram it drops off considerably.

If this is from a double-acting compressor, this might also be due to leakage past the piston if the discharge valves are held open mechanically. The expansion on the suction curve is too long and indicates a high clearance. This might also be brought about partly by leakage past the piston from the other end of the cylinder if the compressor is double-acting, but in any case the pressure during suction should drop to the intake pressure much sooner than it does.

2. To figure this problem we must first find the total number of cubic feet handled per hour by the compressor, then the number of thermal units which will have to be taken from each cubic foot of ammonia by the condenser, and then the number of pounds of water required to take up that amount of heat.

For an 8-in. cylinder the radius would be ⅓ of a foot. The area would be found by multiplying the square of ⅓ by 22÷7, giving 22÷63 sq. ft. area. This is to be multiplied by 1, the length of the stroke in feet, which would give us 22÷63 cu. ft. per stroke, and at 20 per cent slip the amount taken in and compressed each stroke would be 0.8 of that, or 176÷630, and for 2 cylinders would be twice that amount or 176÷315 cubic feet per revolution. At 60 r.p.m. we should have 60 times that, or 2112÷63 per minute, and for an hour we would have 60 times that amount, which works out to 2011.4 cu. ft. of ammonia handled per hour.

To get the amount of heat which must be abstracted per cubic foot, we have the rule: Take the difference in temperatures between the suction and condenser. Subtract this difference from the latent heat of ammonia at the suction temperature and divide the remainder by the volume of one pound in cubic feet at the suction pressure. This will give us the refrigerating effect of a cubic foot of the gas under the operating conditions.

From the tables of the properties of ammonia we find that at 20 lb. pressure the temperature is 5 deg. and the latent heat is 552. At 170 lb. the temperature is 91 deg. Subtracting 5 from 91 gives 86 as the difference in temperatures, and subtracting this from 552 gives 466. The volume of a pound of ammonia gas at 20 lb. pressure is 8 cu. ft. Dividing 466 by 8 gives 58.25 as the refrigerating effect of a cubic foot, or in other words the B.t.u. which must be taken out from each cubic foot of the gas. As there are 2011.4 cu. ft. an hour, we multiply 58.25 by 2011.4, giving approximately 117,300 B.t.u. to be absorbed per hour. A pound of water in being heated from 65 up to 80 deg. will take up 15 B.t.u., and dividing 117,300 by 15 gives 7820 lb. of water heated per hour.

3. The easiest way to find the expansion or contraction of a length of pipe is from a set of curves published in Practical Engineer Reference Tables. From these we find that for 50 ft. in length a change of 75 deg. piping would cause a contraction of 5/16 of an inch and 100 ft. would cause ⅝-in. contraction. The sum of these, or 15/16-in., is the amount of contraction to be taken care of.

If you wish the method by which these values can be computed, you will find the curves and the method in the June 1911 issue of Practical Engineer, the article being on page 420 and the curves on page 130a. Ammonia tables for getting the values used in Fig. 1 were published in the July 1911 issue of Practical Engineer, page 130a and 130b.

4. One gallon of brine will occupy 231 cu. in., or 500 gal. will be 500×231=115,500 cu. in. to be handled per minute. Dividing this by the piston speed in inches per minute will give us the area of the pistons. I have assumed that you will use a double-acting duplex pump, in which case each piston would handle ¼ of the brine needed. Piston speed is 50 by 12 or 600 in. a minute. We should then have 115,500 divided by 4 and by 600, which gives 48.1 sq. in. as the area of one piston. At 15 per cent slip the area required would be 48.1×1.15, or 55.3 sq. in. From a table of areas of circles we find this is 8⅜-in. piston, but would use the 8½-in. diameter.

In your letter you speak of a ratio of piston diameter to stroke of 1/13 to 1. This is so very abnormal that I think there must be an error, and I think it should be 1⅓ to 1. Figuring on that basis, the stroke would be 8½×1⅓ or 11⅓ in., which would be, say, an 11½-in. pump, or for a commercial size would be made 8½×12.

5. The rule for finding the area of a steam piston is to multiply the area of the brine piston by the pressure per square inch and divide by the steam pressure. An 8½-in. piston has an area of 56.75 sq. in. Multiplying by 15 and by 1.1 to allow for the 10 per cent friction loss, dividing by 80 gives 11.70 sq. in. as the area of the steam piston, which is practically 3⅞ in. diameter. A commercial size would be 4 inches.

REVERSING

OLE was running a small hoisting engine with a single eccentric loading coke. The cable interfered a little with the men and the foreman thought that if the drum wound the cable the opposite way it would help matters. So he told Ole to make the drum run the opposite way.

Coming by a short time afterwards he heard some heavy grunting, and a voice complaining "Wat te hale iss te matter mit." Looking in the shack he saw Ole sweating and straining on a crow bar trying to pry the engine loose from the bed and asked, what's up?

"Vella you said make heme vind te odder vay and te only vay I can do it iss to turn te ingene aroun."

Louie, hadn't fired a locomotive very long when he was called to hostle a shift. On one of the engines he had to put in the roundhouse the air pump was out of order so he had to spot her without brakes.

The throttle worked hard and he had most too much speed coming into the roundhouse.

He reversed when near the wall and the engine started back out doors pretty lively. Louie shouted to his helper:

"Shoot te door, shoot te door, kvick!".

A FILING SYSTEM

Easy Method of Keeping Articles and Data for Quick Future Reference

By J. P. Fleming

AFTER trying many different methods of preserving the parts of technical papers, that were most interesting, in such manner as to be readily obtained when wanted, the scheme finally adopted is the one I now use. As the best part of 5 different journals are filed away, covering a period of over 5 yr., I feel justified in stating, from my point of view at least, that it is a success.

Envelopes 10 by 16 in. are numbered and filed in numerical order. Up to the present writing, discarded boxes of proper size have been used for holding these envelopes. In the near future a suitable cabinet will be provided for this purpose.

A card index 3 by 5 in. is used in connection. Subjects are listed alphabetically, the number of the envelope which contains the subject is marked opposite the title in the following manner:

As an example, take index card B, as shown in Fig. 1.

If information is desired on boiler types, first look in index case for card B, and there we find that all articles on boiler types are filed in envelope No. 1, if the subject desired is belting, it is on the same card B, and filed in envelope No. 48.

If there are 2 subjects on the same page, say one on blowers and one on chemistry, the one of greater importance is filed under that head. In this case we will assume the article under the title of chemistry is filed in envelope No. 6.

On index card C is 6, Chemistry.

Then in envelope 14 a sheet of paper, same size as journal page, is filed, on which is written title of article and a notation that it is filed in envelope No. 6.

"Horsepower of Fan Blower," No. 6. Notations can be added if desired, as: "The results of some tests showing the influence which the form of vanes has upon the horsepower and head produced. Formulas are given showing the approximate velocity of flow and horsepower developed."

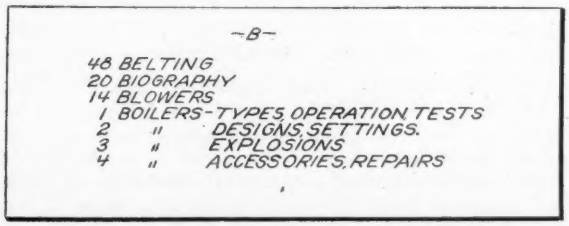


FIG. 1. INDEX CARD "B" FOR FILING SYSTEM

When a number of journals and magazines have accumulated, they are taken apart by removing binding wires and separating the leaves; if a subject covers more than one leaf, the different leaves are pinned together. If, on the other hand, a subject under the same title appears in more than one issue, the article is so marked and the different leaves are pinned together. In any case the leaf is filed intact. That is, if an article occupies but part of the page, as one column or less, this article is marked with a colored pencil and the whole page filed. If there are two or more short articles on the same page under different heads, they can be cut out and pasted on the paper, same size as the journal page. This facilitates handling and is more convenient than the clipping unmounted.

On card B, used for illustration, the numbers run 48-20-14-1-2-3-4. The reason for this is, that when this system was first adopted the number of large envelopes at hand was limited and so boilers headed the list.

It makes no difference where one starts the result will be the same. Suppose envelope number 1 is filled and it is necessary to add another, simply add one

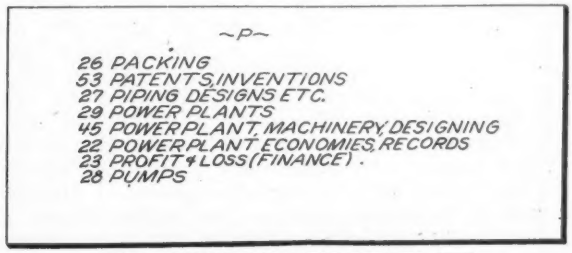


FIG. 2. INDEX CARD FOR LETTER "P"

more envelope to the end of the file and mark it with the next number following, which is in this case say number 66. Then on card B in front of "1 Boiler Types, Operation, Tests," add 66, it will then read:

1-66 Boilers, etc.

When looking for boiler tests use both envelopes 1 and 66. If desired, and it is advantageous to do so, the subject can be divided to suit, as for example:

1 Boiler Types.

66 Boiler Operation, Tests.

In this manner the system can be extended to any reasonable length or size, the subjects can be divided and subdivided to suit almost any demand.

If there is any doubt as to what head under which a subject is to be filed, it can be filed in the envelope apparently most suited and then indexed under any number of heads, taking care that the number of the envelope in which the article is filed appears on the index card before each head under which the article is indexed.

Index card P is represented in Fig. 2.

An article on Power Plant Records would be filed in envelope number 22 and located by referring to index card P under Power Plant Records or on index card R under Records.

This system can be used for filing bulletins, catalogs, letters, etc., and will be found convenient as well as compact. By going over the contents occassionally, dead or useless matter, as well as duplicates, can be removed and destroyed, thus preventing an unnecessary accumulation of undesirable matter.

The principal objection to this system of filing is, that with frequent handling the large stiff envelopes break and tear. This can be avoided to some extent by dividing and subdividing, so that there are but a small number of articles in each envelope. This will facilitate filing and handling; it will also make it easier to secure a desired article when it is required.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

TESTING ROD PACKING

I MADE a test on a large elevator pump to determine the friction caused by compressing the stuffing box gland, in which is used the ordinary packing made largely of rubber. After its lubricating qualities have worn off it grips the piston, as only rubber can, due to the shape of the stuffing box. The pump packings were all taken out, the cylinder head was taken off and eyebolts put in for attaching weights. With all packing taken out, the piston and rod can be turned around with one hand. Packing was put in at 3, and the gland was screwed up not as tight as possible, but nearly so and weights were added until 661 lb. was required to start the piston through the gland. I attached a new low-pressure gage to the indicator pipe as shown, and applied steam until 4½ lb. steam showed on the gage when the piston started to move at the rate of 6 ft. per minute, this 4½ lb. is m.e.p. because it was the same for the whole stroke.

The packing was then taken out of No. 3 stuffing box and No. 2 stuffing box was packed in the same way and the gland screwed up, and then weights were added as before, it required 624 lb. of weights to move the piston, the weights were taken off and steam applied as before requiring 4¼ lb. of steam to move it 3 ft. per minute.

This packing was taken out and the plunger No. 1 packed in the usual way with wet packing for regular duty, the plunger had 4 wedge-shaped segments

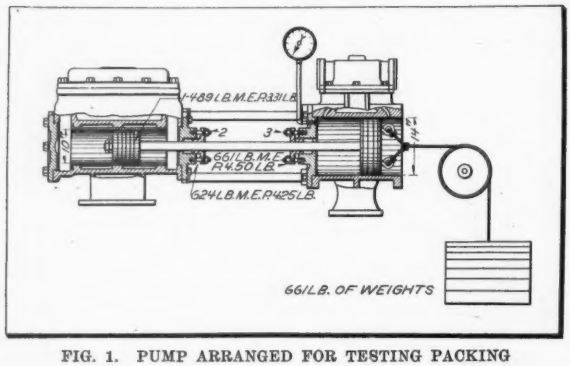


FIG. 1. PUMP ARRANGED FOR TESTING PACKING

which were set out by a cone. Ordinary pressure was given the square duck packing, the same as in general use, weights were then added and it took 489 lb. to start the plunger. Weights were then taken off and steam applied, and 3 1/3 lb. of steam moved the plunger slowly. As I did not have weights enough to start the piston when plunger and glands were put back I could not try it with weights for total piston friction, but since the former tests show that for every pound of steam pressure (m.e.p.) times area of steam cylinder did equal dead weight, it becomes necessary only to screw up the glands to the prick punch mark in the former test, and admit steam until it moved the piston, which it did when the gage registered 12 lb., when it moved at the rate of 2 ft. per minute. A glance at the indicator card will show the difference between this friction and no friction. The pump when pumping with glands screwed up gave a card figuring 45.75 m.e.p., and since we have found the total friction to be 12.10 m. e.p., it becomes plain that the m.e.p. marked 33.6 would do the work if the friction were absent.

While the above compression may be declared by some engineers to have been carried to extreme, every experienced engineer will say it is not an unusual

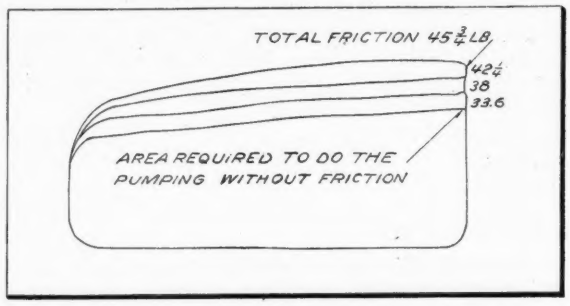


FIG. 2. CARD TAKEN DURING TEST OF PACKING

case by any means, since we have 146.87 sq. in. area times the total friction or 12.10 lb. gives 1774.19 lb. total dead weight required and 2/3 of this will be found in the average plant. I hope that those who are surprised at this enormous friction will try the above experiment, it will be both surprising and instructive.

A. C. Waldron.

RATING OF BOILERS

LETTER relating to Boiler Capacity, page 985 of the October 1 issue of Practical Engineer is very interesting, for, in spite of prevailing opinions, the writer of the letter boldly comes out with an opinion of his own which may perhaps provoke a lot of arguments against him. It seems to me that what he has said about the subject is correct.

A boiler, like an engine, is designed to do a certain amount of work, and allowance is made for possible overload. The overload may be carried, but the most economical load is that for which the boiler was designed in the first place. Making allowance for overload is not a matter of economy, but rather one of convenience. If a boiler is designed to generate a certain quantity of steam in a given time, and future conditions require 50 per cent more steam, it is convenient to overload the boiler to produce the extra required steam, but it will not be economical to do so, for the harder the boiler is worked the shorter will its life be.

Overloading a boiler constantly may be thought to be economical, but in the long run it will not so work out. If a boiler could live up to its overload without showing fatigue, and for an indefinite period of time, then it would be different. We know, without any doubt, that an underloaded boiler is anything but economical. Probably every engineer agrees to that, there is the other extreme, an overloaded boiler, and it is fair to assume that between these 2 extremes there is a certain load at which greatest economy will occur, and this point is in the immediate neighborhood of the load for which the boiler was originally designed. If any given boiler is more economical with an appreciable overload than it is at its rated load—that for which the designer intended to secure the greatest economy—then the designer simply made a mistake in so designing his boiler. Running in the direction of either underload or overload, will result in a loss in economy. It may perhaps not be in the same proportion in both directions, but it is there in some proportion. These things involve an understanding of the relation between capacity, efficiency, and economy. Charles J. Mason.

FILLER FOR SIGHT FEED LUBRICATOR

IN regard to lubricator troubles, I think I have something very simple that would make you kick yourself for not thinking about it before. Of course in our more up-to-date oil pumps we have no such trouble as we used to have, that is all done away with. Now don't get scared when I tell you it is nothing more than soapy water, a shaving off a piece of soap and enough water to fill lubricator glass shook up together in anything that might be handy; try it and see. Take off nut over sight feed glass clean glass off with a small piece of waste wound around a small stick; change if necessary till glass is clear and the dirt is all removed from around the bottom. Do not use a wire in cleaning because if you do and it touches the glass as soon as you turn on the pressure your glass will crack, always use wood inside a glass.

After turning on pressure and opening the valve to regulate the feed you will find the drops to be very small and that they go straight up through the center. You will find that you will not require the valve to be open so much as formerly. This will stay in the glass a long time unless you let your lubricator get empty; in that case your soapy water has gone into cylinder and glycerine or anything else would go the same way. If you have a troublesome glass anywhere I guarantee that it will cure your trouble for ever.

Edward W. Moffatt.

REMOVING SCALE

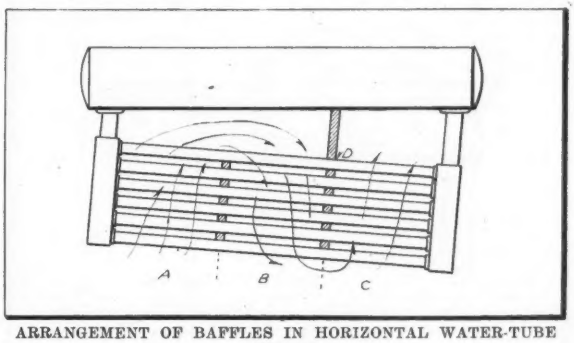
I HAVE charge of a 2500-hp. B. & W. boiler-plant, 5 300-hp. and 4 250-hp. boilers, the boilers were run generally, at 10 to 15 per cent over their rating, but in the course of a few months their capacity began falling, due to scale forming on the outside of the tubes. This continued so far that the rated capacity could not be secured.

In the meantime we were not idle trying to prevent this scale from forming, we tried to blow it off with 140 lb. steam pressure, hammered it, but this was likely to dent the tubes. Everything seemed to be against us. But diligence and perseverance does bring out some solution, in examining some of the scale I found it porous and would take considerable water so I concluded to sweat the tubes which I do in the following manner.

The boiler plant is equipped with Parson steam blowers, in the first place I get the boiler out of service let it, as well as the furnace, cool off, then fill it full up to second gage, with cold water, close the doors and damper, turn on the steam blowers for 24 hr. or longer until the scale absorbs all the moisture it will hold, then I get a hot fire under it as quickly as possible and in the course of a few hours there remains little or no scale. F. C. Becker.

BOILER SETTINGS

THERE can be a very serious mistake made in the purchasing and setting of the horizontal type of water-tube boiler; that is, the type such as shown in the illustration. There have been a great many installations where the length of boiler was too short for the heating surface; that is, by trying to get the heating surface by shortening and increasing the number of tubes, and in some cases making the bank of tubes deeper. Some failures from this cause have been seen by the writer. There is surely a limit to the length of the tubes, as this determines the length of the spaces A, B, C, and this, in turn, is our draft area. Many boiler settings have been bad from this one cause as when you shorten the tubes you necessarily shorten



ARRANGEMENT OF BAFFLES IN HORIZONTAL WATER-TUBE BOILER

this distance and cut down your draft area in proportion and soon you have a water-tube boiler setting that will not show the proper economy nor can you bring up the overload guarantees of the boiler.

There is no one thing of more importance than the setting of water-tube boilers, for the best results, and many poor leaking settings are the results of poorly set baffles. The brick work at D should be well set so as not to allow a leakage through the baffles, as many of these baffles give away at this point and cause poor working of the boiler. C. R. McGahey.

HOW TO DETECT LEAKS IN AIR LINES

IT is well to consider the amount of heat lost due to leaks in air lines, which probably in many cases are overlooked, even though the escape of air is not so prominent as that of steam or ammonia, leaks should nevertheless not be carelessly allowed to exist undetected.

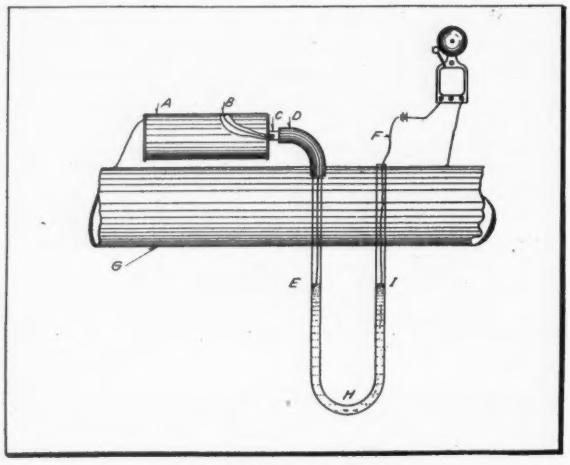
During the writer's experience with air compressors the following method has long been satisfactorily pursued. A sufficient amount of essence of peppermint is put in the air tank and the system carefully gone over to discover the location of the odor, which is readily detected where the slightest amount of air escapes. This test should be given periodically if a standard of economy is to be maintained.

James G. Sheridan.

TEMPERATURE ALARM FOR AMMONIA COMPRESSOR

THE home-made contrivance illustrated herewith is used to give an alarm when liquid is flowing through the pipe from the ammonia compressor, also when the liquid has stopped and the gas starts.

Referring to the illustration, a tin can, A, about 3 in. long and 1 in. in diameter is closed at one end, at the other end a tube C about 1 in. long is soldered into the lid, this is attached by a rubber hose to a glass U tube H partially filled with mercury. On the inside of the can, at B, is soldered a copper wire, which extends out through the connection C and the rubber tubing D down into the U tube until it touches the mercury in the tube. This tube is 10 in. long and is filled about half full of mercury. In the right hand side of the U tube the copper wire F extends to the surface of the mercury and leads to an electric bell and battery of dry cells completing the circuit between the tin can and the bell, the can A and one terminal of the bell being grounded to the discharge pipe G.



TEMPERATURE ALARM

Connect the hose to the U tube when the discharge pipe is about half as hot as it should be; then when the discharge is as hot as it should be, the air in the can A, which is placed directly above the discharge pipe, will expand and drive the mercury from E to I, thus breaking the circuit at E. When the pipe becomes cold, the mercury will drop back to E and make the circuit ring the bell, and thus let the engineer know that the discharge is too cold. Should the discharge continue to get colder, a suction will form in the can and draw the mercury from I to E and break the circuit again. Then, by closing the expansion valve the discharge pipe is made to get hotter and the expanding air in A will drive the mercury back from E to I and as it goes back, it will make the circuit through H, thus letting the engineer know that the discharge is warming up.

If the can is too big and drives the mercury out of the glass, it should be moved farther away from the discharge pipe. If it does not drive it far enough, a dent should be made in the side of the can so it will fit closely to the discharge pipe.

I have found this device exceedingly handy in the operation of our refrigerating plant, and since it is easily made it may be of use to other engineers.

Granville Roop.

IMPROVISED AIR PUMP

OUR whistle is blown by compressed air. Sometime ago the compressor was down for repairs and it began to look as though curfew would not blow that night, when I happened to have a thought. I had a motor driven triplex water pump running against 75 lb. pressure and the top of the air chamber had a ¾-in. pipe tapped in it. I connected a whistle to this, stopped the pump, drained the air chamber, then started the pump again and had 75 lb. of air with which to blow the whistle. Chas. Sawyer.

AIR COMPRESSOR CARDS

IN answer to Frank Richards' and A. C. Waldron's criticisms of my air compressor cards, I would say that as this air compressor, from which the cards published in Sept. 1 issue of Practical Engineer were taken is tandem connected to the steam cylinder, it is evident that the greatest amount of work is done at or near the end of the stroke or point of discharge.

In order to have the air compressor do its rated amount of work the speed must be uniform throughout the stroke.

When the steam admission valves are set so as to give an earlier admission and produce an almost perfect card the compressor slacks its speed at the end of stroke.

This is due to the steam or initial pressure dropping too low due to an early admission and cutoff. Therefore the steam valves have been set for late admission. As this engine is equipped with single eccentric, the exhaust valves are also late.

No steam cushion is really needed at the end of stroke as the air cylinder furnishes all the cushioning that is needed for quiet running of the engine.

The expression "valves in the piston and piston rod" was a mistake on my part, it should have been "inlet valves are in the piston" or in other words "piston inlet."

Mr. Richards is quite correct in stating the age of this type of compression, that is, piston inlet type to be about 20 yr. old in fact the compressor is 18 yr. old, while the steam end is 32 yr. old.

The speed of compressor when cards were taken was normal or 50 r.p.m.

Immediately after the cards were secured steps were taken to remedy the defects. First the load was equalized for each end of steam cylinder. Changing the length of the governor rod equalized the steam admission for each end of cylinder.

The inlet and discharge valves of compressor were next examined, washed and cleaned with kerosene and reseated with ground glass, after which a card was taken which gave us a quicker closing of the inlet valve at the beginning of compression.

The reason I sent the cards for criticism was this, so many engineers always look for or want a theoretically perfect card or nearly so because books seldom give the actual working conditions a thought.

In my experience with engines of one kind or another, I have found that some working conditions of engines, in order to get best operating results, cause changes in the theoretical or ideal card.

I have found that in tandem connected air compressors, or in any other cases where the greatest amount of work or load comes at the end of the steam stroke, that the steam admission should be late in order to do the required work in the easiest and most satisfactory manner.

Some time ago I had a collection of peculiar cards taken from different engines throughout the southern part of this country where running conditions are a great deal more severe than here due to water and climate, that would astonish most engineers by their peculiar shapes and forms.

But it was the only way to get the most work out of the engine sometimes sacrificing coal to do so, in other cases peculiar diagrams were the results of our trying to save coal and steam.

Taken altogether the ideal condition of operating is to secure the most amount of work for the least amount of coal and wear and tear of machinery.

C. E. Anderson.

INCREASING ENGINE CAPACITY

IN Oct. 1 issue W. A. W. submits what he calls a card from an over loaded engine, 26 by 48, 80 r.p.m., boiler pressure 140 lb. which is answered by G. W. Wallace. To begin with the cards show very good steam distribution, but I fail to see why the engine is overloaded from the card submitted, because it only shows a 20 per cent cutoff, which with a 48-in. stroke would be 9 3/5 in. and an engine with twice that cutoff is far from being loaded. Mr. Wallace advises him to advance his eccentric but I fail to see how an engine can do anything but decrease its power for every inch the eccentric is advanced because it decreases its range of cutoff, also adds compression which decreases the area of the card and m.e.p.

I regret that the scale of spring is not given by W. A. W. as we could be more accurate in this research but as Mr. Wallace has assumed a 60 lb. spring we will work on this basis and call the m.e.p. 70 lb. as found. Now the most wasteful part of these cards is the high terminal pressure which is about 16 per cent of the initial pressure and the fact that he has no compression is wasteful and should be remedied. First the engine should be speeded up say to 95 r.p.m., that is after a larger pulley is put on the jack shaft so that the mill shafting will maintain the same speed as before, this increase in speed will increase the horsepower of the engine because it will cutoff shorter and when cutting off shorter the expansion line will release nearer the atmospheric line, and the terminal pressure will be low and consequently the economy will be greater. Before this change in speed the engine had a constant of 10.2960 at 80 rev., after increasing speed to 95 rev. we have a constant of 12.2275, giving an increase in horsepower of 135.205. Since the engine only needs to do 720 hp. it is obvious that it will shorten up its cutoff until the card shows a m.e.p. of 59 lb. which, multiplied by the present constant of 12.2275 gives the same horsepower on the shorter cutoff and higher speed, as it did with the original speed at 95 rev., hence it has increased its surplus supply of available yet unused cutoff range, which makes the engine more powerful than before. The terminal pressure will now be lower because the cutoff is shorter and the saving in coal will be apparent. I would next change the exhaust rods to increase the compression which will also make a showing in economy.

I find by plotting the adiabatic expansion line that the steam valves are leaking, however, the main thing is to decrease the high terminal pressure for economy and that can be done as stated above by increasing the speed and getting a shorter cutoff but before increasing the speed I advise you to find the rim speed of your flywheel. 6000 ft. per minute is the standard safe rim speed, and if you do not feel like increasing the speed you can get more power from your engine by decreasing the lap of your steam valves and putting your eccentric back to correspond which will increase your range of cutoff.

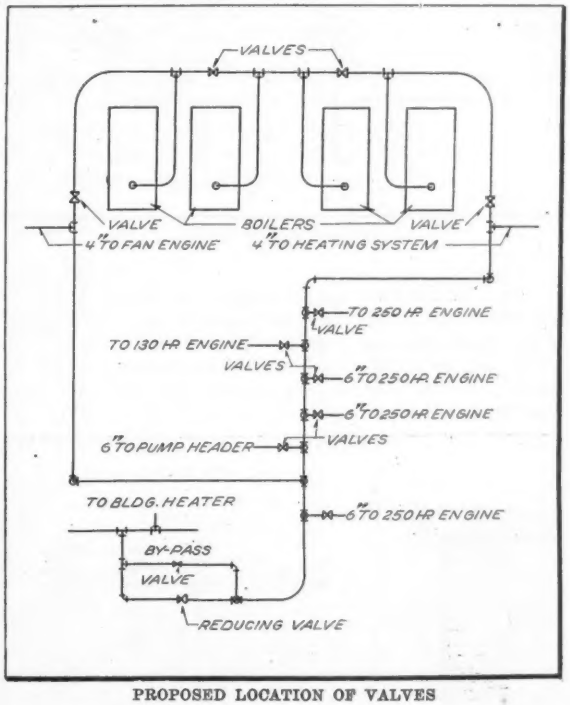
A. C. Waldron.

LOCATION OF VALVES; WATER LEVEL

IN looking over my Practical Engineer for Oct. 1. I see that Mr. Hudson has given his ideas in regard to the proper number, and position of valves for Mr. Hawkins' boilers as requested in Aug. 1 number of Practical Engineer.

The accompanying sketch will explain my idea perfectly. Mr. Hawkins mentions the fact that at times 3 boilers are necessary to carry the load. You will see by the sketch that either 3 of the boilers may be used while the other one is idle.

I also notice that Mr. Hudson criticises Mr. Crowther's plan of carrying the water in his boilers as high as possible without having them prime. In my opinion Mr. Hudson is correct in his criticism. The lower you can carry the water in your boilers the easier they will steam. Of course the water should not be carried so low as to be dangerous.



PROPOSED LOCATION OF VALVES

It is plain that if you carry the water at the lowest line, you will have a larger steam liberating surface than if you carry the water at the highest line. The boiler will steam easier and respond to the fireman's efforts quicker than it would if you carried the water at the higher point because there is less water to heat.

In other words, it is easier to heat a small body of water to the boiling point than it is to heat a large body of water to the same point.

I have the water column on my boiler set so that when the water just shows in the glass there is about 1 in. over the flues. By carrying 2 gages of water in the glass I have plenty of water in the boiler, although I have seen boilers with the water column set so high that with 2 gages of water in the glass there would hardly be any room for steam.

W. P. Flint.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Repairing Engine Parts

IN a 24 by 24 in. direct-connected high speed automatic engine, with a speed of 150 r.p.m. the crank pin which was put in as shown in Fig. 1 with a taper fit and then pened over, worked loose. It became necessary to put in a new one so the pened end was cut off with a chisel and sledge and then a 35-ton roller jack was placed as shown in Fig. 3, and 3 men on a long bar on the jack failed to make it go until a sledge was used on the outer end of the pin.

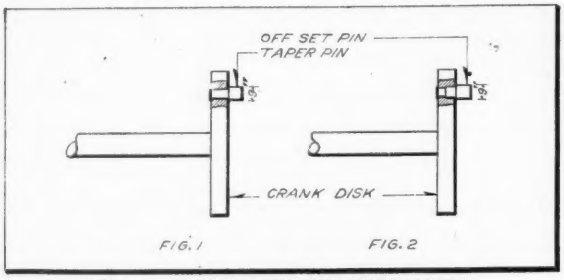


FIG. 1. TAPERED PIN FORMERLY USED
FIG. 2. OFFSET PIN

The hole for the pin was rebored as shown in Fig. 2, and pin made a little large and was forced in by means of the jack again as shown in Fig. 4, and then the end pened over on the disk. The new pin has been in use for several months and has not shown any sign of coming loose again.

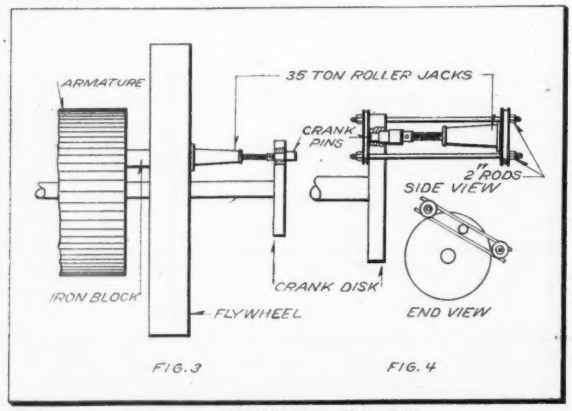


FIG. 3. REMOVING OLD PIN
FIG. 4. FORCING NEW PIN IN PLACE

It is claimed by some engine builders that the offset method of putting in crank pins is preferable, as it makes a better fit than a tapered pin and when a tapered pin gets loose, it is apt to get looser than with one of the offset type.

On the same engine, where the cylinder joins the guide block, were 2 flanges as shown in Fig. 5. The cylinder was bolted to guide block by stud bolts in the cylinder, passing through the first flange in guide block and having nuts on the end, securing guide block to cylinder. After several years service the engine broke in two between the 2 flanges as shown in Fig. 5, thus leaving the cylinder loose with a flange of the guide block bolted to cylinder. This break was caused by the foundation giving away.

It was almost impossible to shut the plant down long enough to put in a new block, also a great expense for a new piece. A set of 1½-in. iron rods and 2½-in. steel bars with holes in them for the rods to pass through were put on as clamps to hold the cylinder on for several weeks until it could be properly repaired.

The engine, while not doing first-class work by any means, was run day and night for several weeks in this condition. Then holes were drilled through the other

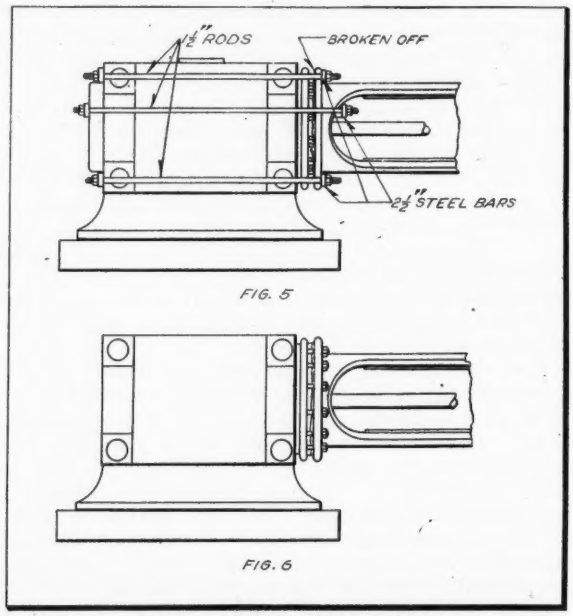


FIG. 5. BROKEN GUIDE BLOCK
FIG. 6. METHOD OF REPAIRING BROKEN GUIDE BLOCK

flange in line with the holes in the flange broken off and with those in the cylinder and longer stud bolts used as shown in Fig. 6. The engine has run day and night for several months since being repaired and appears to be as good as new. The engine was relined and reset and new grout put under it, thus making a good foundation.

The piston of this engine was of the type shown in Fig. 7. It was made of 2 separate castings riveted together and threaded and screwed on to the rod and the rod pened over on the end. After a while the rod became loose and also worn so that it became necessary to put in a new rod.

The old rod was taken out and the hole in the piston turned up, which made it too large for the rod after being finished, so a rod was turned down out of a larger rod and a shoulder or collar had to be left on it so that

the piston would fit closely. The rod was pened on the outside and a pressure fit of 60 tons was used to place piston on rod. The piston has given satisfaction for several months of use.

In a 12 by 7 by 12 pump used to feed boilers with hot water, we were troubled with the valve seats becoming loose and going down through the valve deck casting

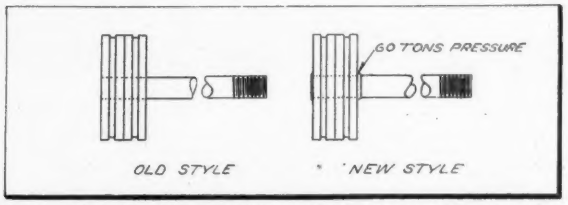


FIG. 7. FORMER AND PRESENT METHOD OF SECURING PISTON

which was of cast iron and appeared to be rather rotten or eaten up. The threads of the seats, which were of brass, were in fairly good shape except where worn by working of loose seats, but threads in iron casting were all gone.

Castings were bored out and new threads cut and new blank valve seats of brass were ordered which were of larger diameter than the old seats. The new seats were finished with a flange and shoulder at the top. The new seats, though larger in diameter than the old seats,

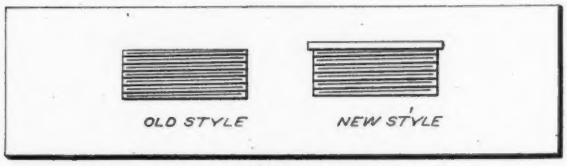


FIG. 8. OLD AND NEW STYLE VALVE SEAT

were made to use the same valves. After castings were rethreaded, the threaded portions were white-leaded thoroughly and then screwed into place, after which the pump was ready to run.

I would like to know the cause of loose seats in the first place, whether action of water or not as most of the feed pipe has had to be renewed. O. L. Harper.

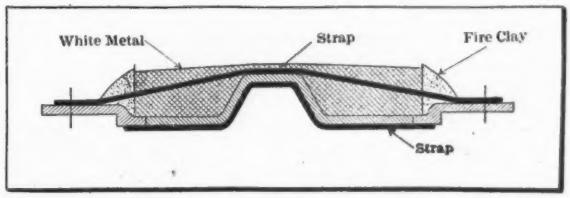
Emergency Repair to Pump Cover

SOMETIMES, especially on board ship it is necessary to make a temporary repair with any material which is to be found, and the method here shown is one that was used under such conditions to fix the cover of a ballast donkey engine. The story is told by F. B. Foster in International Marine Engineering.

There happened to be a flaw in the piston rod, close to the neck of the crosshead, and as the pump was kept working for some days without cessation, even day or night, the strain was too much on the rod, and it snapped off short. The result was that the piston traveled up further than its stroke, and struck the cover breaking it round the inside of the flange, the cover coming away in 2 pieces, leaving the flange intact.

Fortunately, there was on board a piece of iron that was suitable for making a new rod, so that this part of the difficulty was overcome fairly speedily. As, however, the original cover had been raised in the center, or dished out, in order to allow the end of the rod to work up into it, it was impossible, without a great deal of trouble, to make a new cover out of a piece of plate, which would have been the usual course to pursue. It was also impossible to get another complete pump cover cast before the time of departure of the ship, so that a much more risky and temporary repair had to be resorted to.

With the aid of some red putty and cement, the pieces of the cover were stuck together so that they were secured to their proper places. A piece of flat iron, 1½-in. wide by ⅛ in. thick, was cut and bent to take in the broken pieces, and it was riveted to the under side of the cover. Another similar piece was made to fit over the outside of the cover, and to pass over 2 of the cover studs.



DETAILS OF PUMP COVER REPAIRS

When the cover was screwed down these straps drew the broken parts together tightly, and after the cover had been put into place and jointed down, a strip of tin was placed around the outside of the broken parts to form a kind of tray, and inside this fireclay was built up so as to form a solid mass. The whole repair was then run up solid with white metal, the general appearance of the repair being as shown in the sketch. The pump was running nearly every day for 3 mo. after the date of repair and before a new cover could be obtained, and not the slightest leak of steam was apparent.

Pressing in Crankpin

SOMETIME ago the crankpin of a Holly quadruplex pumping engine was broken off flush with the face of the crank and as it was needed for service, it was a day and a night job. Figure 1 B shows how 1-in. holes were drilled into the piece of pin, remaining in the crank, and it was then driven out. The new pin was fitted and Fig. 2 shows the method of pressing it in. A is the crank, B the new pin, G is

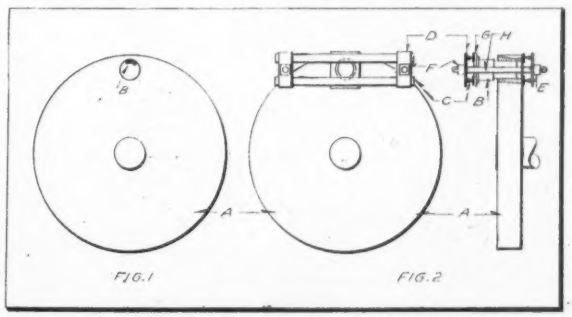


FIG. 1. METHOD OF REMOVING BROKEN CRANKPIN
FIG. 2. PRESSING IN CRANKPIN

a heavy plate laid across the end of the pin, to afford better bearing for the pieces of railroad rail CC. Across these in turn were flat pieces of iron DD, serving as washers. The bolts H were 2 in. in diameter, having a standard nut on one end, E, and 10 threads per inch on the other, F. The nut, F, was about 4 in. long so there was no danger of stripping the thread. A heavy wrench was used on these, and as the pin entered farther into the crank, a piece of pipe was placed on the end of the wrench.

Tom Jones.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Steam Engine Questions

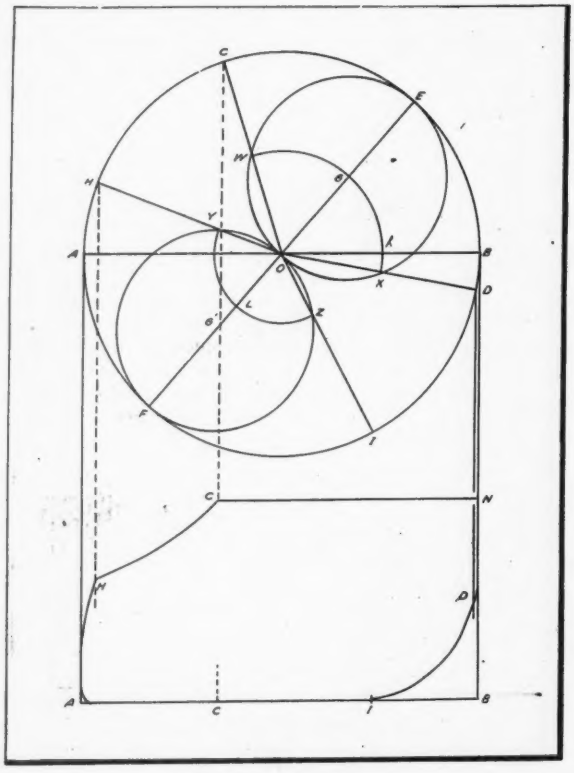
WHAT is the proper length of an indicator diagram from an engine with a 42-in. stroke ?

2. How is the proper length of an indicator diagram determined for any stroke and how do you find the proper bushing for the reducing wheel?

3. Suppose a slide valve cuts off at ¾ stroke and a ⅝ cutoff is desired; how would you proceed?

4. What is the difference between a barometric and a syphon condenser?

5. How do gravity sight feed lubricators with one connection work?



VALVE DIAGRAM

6. What would be the effect upon a steam gage if a water trap were not placed between it and the boiler?

7. With same area, will a spring pop safety valve discharge more steam than a lever safety valve?

8. What is the limit of cutoff obtained either early or late and what is the cause on a slide valve engine?

9. What effect would oil have on a Manning boiler?

James Reid.

A. There is no rule as to the length of an indicator card with relation to the length of the stroke of the engine. The length of the stroke is immaterial. The length of the indicator card is determined mainly by the diameter of the drum on the indicator as it can readily be seen that a longer card can be taken on a 2-in. drum than it can on a 1½-in drum.

As a general thing, it is best to so arrange your reducing motion that you will secure a card 3½ in. long, or if you have an indicator with a 2-in. drum, a 4-in. card can be secured with ease, but avoid taking a card shorter than 3-in., as to do so tends to conceal some of the principal features of the card and thus defeat the object for which the card was taken.

2. As there are several different kinds of reputable reducing motions on the market, each of which is somewhat different from the other, it is not possible for us to say, only in a general way, how to select the proper bushing to take a card of a given length. Some indicator makers, however, stamp the bushings with small figures which show that each is intended for a given stroke.

If the bushings are not marked, proceed as follows:

Assume that the stroke of the engine that it is proposed to indicate, has a stroke of 36 in. Then select a bushing of medium size and prepare the indicator for use with a paper on the drum. Now measure off on the frame of the engine a distance of 36 in.

Then with the long cord that attaches to the crosshead, gently draw a given point on the cord along the measured course, meanwhile taking note as to the length of the line that is drawn on the paper by having an assistant hold the pencil on the paper, at the same time taking note whether the drum touches the stops at either extreme of travel or not. If the line is too short, put on a larger bushing and if it is too long put on a smaller bushing.

3. Having a given slide valve which cuts off steam at ¾ stoke, and wishing to change the point of cutoff to ⅝ stroke, rotate the engine in the direction in which it is to operate, until the piston has reached a point equal to ⅝ of the stroke from the beginning.

Then rotate the eccentric around the shaft in the direction in which the engine is to run, until the valve cuts off and fix it to the shaft, and if the work is correctly done the engine will now operate, cutting off at ⅝ stroke. This disposes of the question as far as your inquiry is concerned.

However, there are several other functions of the valve which would be seriously affected by the procedure mentioned above. If the eccentric is advanced on the shaft, this makes all the events earlier in which case the steam would be released earlier, the compression would be earlier and admission would be so early as to distress the engine.

All these things taken together would tend to extravagant waste of steam, so in order to make the change that you propose, it would be necessary to add lap to the valve and to do this properly, lay out a valve gear diagram in accordance with the case in hand and having located the points of inlet and cutoff, the point half way between these 2 points would be the angle of advance of the eccentric.

We will assume that the travel of the valve is the same as the diameter of a circle, the radius of which is the radius of the eccentric, and which we will say, in this case, is 3 in. Then the distance A-O is the radius of eccentricity and twice this, or 6 in. is the valve travel. We are also assuming that there is no reducing motion between the eccentric and the valve, and that the valve travel is just twice the radius of eccentricity.

So we will draw a circle on the line A-B, with the radius of eccentricity, A-O, as a radius and from the points A and B drop perpendicular lines and establish the base line A-C-I-B. Now it is desired to design a valve which will cut off steam at five-eighths of the stroke, so on the base line measure off 5/8 of the base line, which will be found at the point C, and from this point, erect a perpendicular which will intersect the travel circle at the point C, and draw the line C-O.

This is the starting point. Now, draw the line O-D, which will meet the travel circle at D, which is located at a point determined by steam pressure, speed and good judgment. When the point D is located on the circle, it represents that point where the crankpin is located when admission takes place.

Having located the points C and D, bisect the arc C-D, at E and draw the line F-O-E, which gives the angle A-O-E, which is the angle of advance of the eccentric ahead of the crank pin. Now from the points G and G, on the line E-F, with a radius equal to half of A-O, draw the 2 small inscribed circles, which are known as valve circles. This circle will be found to have crossed the lines O-C and O-D at the points W and X and with O-W as a radius, draw the arc W-G-K-X, which is called the steam lap circle, and the distance O-W or O-X, will be the amount of steam lap to give the valve, which will be found to be 1.531 in. This disposes of the steam end of the valve.

In a slide valve, it is known that the later the release, the earlier the compression will be, therefore in order to decide what amount of inside, or exhaust lap, to give the valve it must be a compromise between the two, so as a trial locate the point H on the circle and draw the line O-H, which will cross the valve circle at the point Y. Then with O-Y as a radius draw the exhaust lap circle Y-L-Z and then draw the line O-I which will intersect the valve circle where the exhause lap circle touches it at Z.

The point I represents the place in the crank pin circle where the crank pin is, when compression begins. It can now readily be seen that if the point H was located nearer A that the exhaust lap would be greater, thus bringing the point I closer to F, which would increase the compression too much, in addition to having release take place so late in the stroke that exhaust would not be free and would cause a back pressure on the piston.

Having decided on the proper location of the points H and I, measure the distance O-Y or O-Z which will be found to be just an inch, which will be the amount of exhaust lap to give the valve.

Now, from the base line below, A-C-I-B, erect perpendiculars to the points H, C, D and I. Draw the line C-N, parallel to A-C-I-B, and at a distance from I about equal to a half of A-B. This line represents initial pressure in the cylinder and by sketching in the various lines you can get a fair idea of what an indicator card would look like if taken from an engine equipped with such a valve as we have designed.

A-B represents the atmospheric line on which compression begins at I, and continues to D where the admission takes place. Cutoff takes place at the point C, which is determined by the question as 5/8 of the stroke. Expansion takes place from C to H, then release takes place at H and the exhaust valve remains open until the point I is reached when compression begins again, thus completing the cycle. This represents a card and also the various events of the valve movement as applied to one end of the cylinder only. Those for the other end will be identical. In these calculations, no mention has been made of the angularity of the eccentric rod, as this is so small in the ordinary slide valve engine that it is neglected entirely. It is only in short connected high speed engines that the angularity of the eccentric rod enters into the designing of a single valve to perform all the various functions of the cycle.

4. A syphon condenser is one in which the condensing water in falling through the tail pipe passes through a sort of combining tube very much the same as an injector, or ejector, which is located at the top of the tail pipe, and the action of this falling body of water creates a vacuum in the exhaust line. The exhaust steam is condensed by coming in contact with a solid body of the condensing water, and the supply of condensing water remains practically constant, irrespective of the load on the engine, and consequently, the amount of steam to be condensed. This type of condenser will elevate its condensing water 15 to 20 ft. by the syphon action of the water passing down the tail pipe, hence the name. A syphon condenser will serve every purpose where a vacuum of not to exceed 25 in. is desired, and where simplicity and reliability are the main considerations.

In a barometric condenser, while the general scheme is very similar to the syphon condenser, there are several points where there is a wide difference. In this condnser the injection water instead of passing through a combining tube as in the case of the syphon condenser, passes through a spraying device whereby the steam is brought into more intimate contact with the water, and the supply of water is automatically regulated to suit the amount of exhaust steam to be condensed, depending on the load on the engine.

In the barometric condenser, however, a dry vacuum pump is provided to maintain a vacuum having the suction end situated in the condenser head in such a manner that it will readily extract the cool gases liberated by the condensing steam. With this type of condenser, a high vacuum can be maintained under conditions covering a large range of operating conditions.

5. In a single connection gravity lubricator, a small loop, usually of small copper pipe, is connected from the top of the condensing chamber which rises to a height of about 6 to 8 in. then loops over and enters the top of the main steam connection to the steam pipe or chest. In operation, steam enters the loops at the main connection and passes over the top of it where it is condensed, thus creating the necessary head so that the cylinder oil will feed promptly.

6. If a steam gage were to be connected to a boiler without a syphon or trap between them, the temperature of the steam entering the hollow delicate spring of the gage would cause such undue expansion as not only to cause the gage to register perhaps 75 to 100 lb. in excess of the actual pressure, but would cause a permanent defect, which would not only be faulty as cited above, but would not register accurate within several pounds at all pressures when the gage should be tested at any one certain pressure, with a gage known to be accurate. For instance, if a steam gage which was connected to the steam space of a boiler should be found to be defective

and should be again set accurately at, say, 80 lb., when the pressure should rise to 120 or 125 lb., or drop to 35 or 40, the gage might then be found to be several pounds out of the way.

7. In a lever safety valve, the working parts are constructed as good perhaps as is possible with the design, yet with all the care used, there is considerable friction in the moving parts, and these coupled with the fact that the resistance to the exit of the steam is a "dead weight," makes the operation of these valves at best very sluggish. On the other hand, the seat of a pop or spring loaded safety valve is made in such a manner as to provide a guide for the valve and as the tension of the spring is along the axis of the seat and is held in compression on 2 steel points, it necessarily follows that the pop valve is more prompt in yielding to the pressure of the steam.

Practically all pop valves are designed in such a manner that the escape of the steam tends to hold the valve farther from the seat and thus "blow back" a few pounds before the valve seats, while the design and construction of the lever valve does not permit of this refinemnt and therefore is not as efficient as the pop valve of the same area and operating under the same conditions.

8. Strictly speaking, there is no limit early or late, to the cutoff of a slide valve. Until recent years when modern methods replaced them for isolated elevator service, a type of engine was very common for the operation of elevators, in which the valves had neither lap nor lead and would operate in either direction whichever way they were started by means of an auxiliary valve operated from the elevator cage. On the other hand, on an engine with a shaft governor operating a slide, or piston, valve, friction load compels that cutoff take place early in the stroke, so early in fact that frequently cutoff has taken place before the crankpin has crossed the center at the end of the stroke, and if when the engine is at rest, the governor be blocked in a position a little in excess of the position occupied at friction load, the valve will cover the ports at all times during a complete revolution of the wheel and it will be impossible to start the engine from any position.

In engines with a slide valve and a constant valve travel, cutoff seldom takes place earlier than 55 per cent nor later than 75 to 80 per cent of the stroke. This refers to conditions where one valve takes care of the 4 functions of the valve.

9. Oil introduced into a Manning boiler will tend to cause distress the same as in any other kind of a boiler. It will combine with certain impurities in the water which usually float on the surface, and they will then either adhere to the tubes or else settle to the bottom.

If these impurities attach themselves to the tubes, there is a danger that the tubes will be overheated and thus cause a collapse of the tubes. If they settle to the bottom of the boiler, they may cover the lower tube sheet in such a manner as to cause over heating of the sheet and possibly a rupture or explosion, while if they settle in the waterleg and adhere to the sheets of the firebox, there is also a tendency to blister the sheet.

As the design of the Manning boiler is such that all of the tubes pass through the steam space, they deliver dry, and in fact slightly superheated steam, and if the boiler be fired heavy, there is a possibility that if oil of a low flash point be introduced into the boiler, the gases arising from it will be ignited from coming in contact with the hot tubes and cause an explosion, if the exit of the steam should be stopped just at this time so that the gases could not pass out of the boiler until the safety valve would permit. G. H. Wallace.

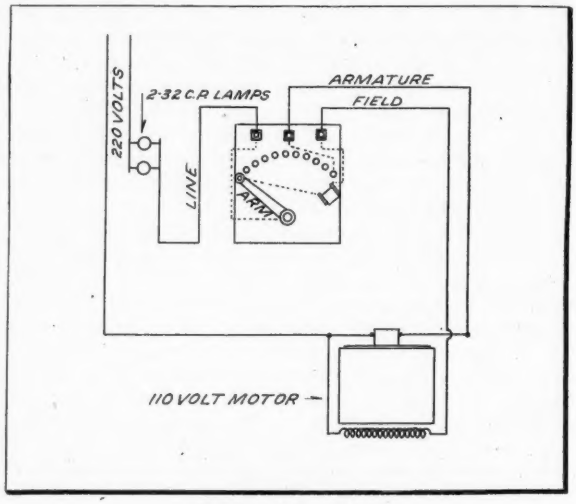
Replacing Economizer Scrapers

WE have trouble in replacing scrapers in an economizer, because we have to take the top cap plates and caps off to do this. Is there any better way?

A. If the economizer has ovoid bottom headers, the scrapers should be placed on the economizer from the soot pit chamber between the bottom headers, where there is plenty of room to get the scrapers in.

Running 110-Volt Motor on 220-Volt Circuit

I HAVE a 110-volt ¼ hp. shunt-wound motor that is to be supplied with current from a 220-volt circuit. Please advise me if the accompanying sketch of connection is right; if so, could you give me a formula for figuring the current required?



CONNECTION DIAGRAM

A. Use 4 110-volt lamps. The formula for the required current is $\frac{746}{4 \times 110} = 1.7$ amp.

Compressed Air-Driven Pump

WE have an air compressor at our shaft on the surface and about 1200 or 1500 ft. from the shaft bottom. We have a No. 9 Cameron pump that we are running with compressed air, but it will only run from one or 2 hours at a time without freezing and stopping. After it once freezes and is started again it will only run a half hour till it again freezes and it takes from 3 to 4 hr. for it to warm up again before we can get another 2 hr. work out of it.

We have a condenser or tank about 500 ft. in and put another small one at the pump to drain the water before it gets into the pump, but this even does not have the desired effect. What can we do to make it work satisfactorily? P. R.

A. I presume you understand the reason for the freezing up of your air driven pump. When the air is heated up by compression, it is able to hold a good deal more moisture than when it is cool. The water condenses out to a certain extent as the air cools in transmission, but when it begins to expand and do work in the pump cylinder, the temperature falls still further and more water is thrown down, which in turn still further cools the incoming air until the whole thing freezes up solid.

About the only remedy for your difficulty is to use a reheater near the pump. This will have 2 effects: First, it will prevent the freezing up, because the air will enter the pump at a temperature high enough so that even after expansion it will not throw down and freeze the water which it carries; second, it will very considerably improve the efficiency of your air in running the pump. This comes because by the reheating of air, its volume is considerably increased and thus a less number of cubic feet have to be furnished by the compressor to do a given amount of work. Such a reheater can be obtained from the Ingersoll-Rand Co., New York, and it is found that the reheater adds something like 25 to 35 per cent to the amount of work done by the air. A. L. R.

Heating Problem

PLEASE inform me how large a pressure reducing valve would be required to maintain a pressure of 2 lb. on a heating main having 20,000 ft. of direct radiation. This must be supplied direct from the boilers after shutting down the engine at noon and at night. The boiler pressure is 125 lb. in the daytime and is allowed to fall to about 40 lb. at night. O. G. B.

A. We figure that it would require a 14-in. main to carry sufficient low-pressure steam to supply 20,000 ft. of radiation. It is customary when using a pressure reducing valve, reducing from a high boiler pressure to a low heating pressure having a large main, to use an expanded outlet valve, and in this instance we would recommend an 8 by 14-in. valve, which is a standard size.

Charges for Heating

THERE is a firm close to our power house that wants to get steam from us for heating, also hot water for washing purposes and would like to have 2 ½-in. bib cocks. We have the Webster vacuum system and a hot water generator that keeps the water at 165 deg. F. Now, what I would like to know is just how to figure this cost for steam and hot water only.

G. W. H.

A. As to your inquiry, the usual price for steam for exhaust heating is from 30 to 40 cents per square foot of radiation per season. The price on hot water heating, I would not know how to figure. This all depends on the amount of water to be used.

Your letter states 2 ½-in. bibcocks; if these are used continuously, they can't take up a good deal of steam and water. If they are used for ordinary toilet purposes, they will take but little. It will take about a pound of steam to heat a gallon of water, and the usual price charged for exhaust steam when it is metered is from 50 to 70 cents per 1000 lb. A. L. R.

Mathematical Problem

A LADDER 70 ft. high is placed against a wall perpendicular to the ground. A bird is standing at the middle of the ladder; now, the bottom of ladder is gradually pulled away from the wall until the top end of the ladder is on the ground touching the wall. How far did the bird travel if standing still at the middle of the ladder? J. P.

A. Any point in the exact center of a 70-ft. altitude which you describe in your problem, under the conditions named, will describe a quarter of a circle. the distance traveled will be:

$$\frac{3.1416 \times 70}{4} = 54.98$$

N. G. M.

Combustion Problem

IF in a furnace of 75 sq. ft. grate area, 1200 lb. of coal are consumed per hour at a temperature of 1950 deg. F. and evaporating 6 lb. of water per pound of coal, how much more coal will be consumed and water evaporated if the temperature is raised to 2300 deg.?

F. C. B.

A. The problem is not one which can be definitely answered, nor could it be even if all the data of conditions were given. In Bulletin 23, Department of the Interior, on Steaming Tests of Coals and Related Investigations, there is given on page 226 a set of curves to indicate the effect of combustion chamber temperatures on results of tests. It is stated that the object of compiling this chart was to show whether in general high furnace temperatures are conducive to high efficiency.

If it were proper to apply the results of these data to your problem it would show that a combustion chamber temperature of 1950 deg. develops 78 per cent of rated boiler capacity and with temperature of 2300 deg., 92 per cent capacity. The efficiency at 1950 deg. shows 64.4 per cent, while a temperature of 2300 deg. shows an efficiency of 65.2 per cent. This is equivalent of 17.9 per cent increase in capacity and 1.25 per cent increase in efficiency.

This applied to your problem would mean that since at present you are evaporating 7200 lb. of water an hour, the increased efficiency and capacity should give you $(7200 \times 1.179) \div (6 \times 1.0125) = 1400$ lb. of coal an hour, or 18.7 lb. a square foot of grate. The amount of water evaporated would be 7200 lb. $\times$ 1.179 = 8500 lb.

An examination of a large number of tests indicate that there are no infallible deduction to be made as regards definite amounts, but that the general trend of increased furnace temperature is toward higher efficiency and unquestionably towards higher capacity. The efficiency would be affected by the amount of air supplied and the proper mixture of air giving most efficient percentage of carbon-dioxide.

P. M. Chamberlain.

Heating of Generator Fields

WE have 2 General Electric a.c. 133-cycle generators which have recently begun to lose their voltage. After running about an hour or 2 they will drop from 15 to 30 volts. The generators are up to speed and we have boosted the exciting current to 140 volts. The fields after 2 hr. are excessively hot. Kindly advise me what you think to be the probable cause of the trouble. B. C. P.

A. Heating of the field coils is probably due to short circuit in the coils themselves, or if the machines have been in service for a good many years the insulation on the coils may have deteriorated to such an extent as to cause some leakage between turns.

E. W. Allen.

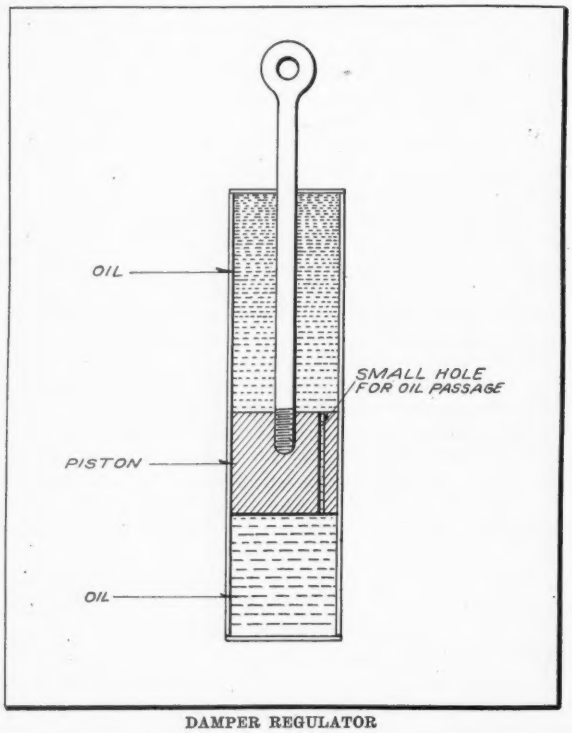
THE ARMSTRONG CORK CO. announces the opening of a new branch office of its insulation department, in the Plymouth Building, Minneapolis, Minn. This branch is in charge of H. B. Gates, formerly of the Chicago office. The territory in his charge includes: Minnesota, North Dakota, South Dakota, Montana—East of the 110th Meridian, the Northern part of Iowa and the extreme Western section of Wisconsin. The opening of this new office is intended materially to facilitate the handling of the company's business in that portion of the country.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Fluid for Damper Regulator

CAN some reader of Practical Engineer tell me if there is anything in the line of oils or other fluids that does not get as thin as ordinary engine oil when warm and very thick when cold?



DAMPER REGULATOR

I have made a damper regulator and have tried to operate it with ordinary engine oil, but it was affected too much by changes in temperature. The accompanying sketch shows the regulator. Frank Kriz.

Civil Service Examination Questions

THE following list of questions was asked at a civil service examination for First Class Steam Engineer some time ago. The time allowed to complete the full examination was 8 hr. which also included writing a letter to the Civil Service Commission of not less than 150 words on one only of two subjects given which were: "The Advantages of Motor Drive over Belt Drive for Individual Machines"; "Recent Developments in Electric Lighting Machinery." The questions asked were as follows:

1. Draw a diagram of a water tube boiler showing by arrows the circulation of the water and the path of the gases.

2. State fully the advantages and disadvantages of a tubular and water tube boiler.

3. What is corrosion? What is scale? How is each caused?

4. How would you prevent them from forming?

5. How would you remove them when formed?

6. What is a condensing engine? How does it differ from a noncondensing engine?

7. Describe with sketch the action of a surface condenser, also a jet condenser.

8. What would govern your choice of a condenser?

9. Draw an indicator diagram from a noncondensing engine naming all the events and lines.

10. Figure the horsepower of an engine, average height of the head end and crank end diagram 4.34 in., length 3 in., scale of spring 60 lb., cylinder 12 by 12 in., 120 r. p. m.

11. If you had the blue print of an engine foundation, state fully and in detail each step you would take in building the foundation and erecting the engine.

12. What is the use of an expansion tank in a hot water heating system, what precautions should be taken in installing and piping it?

13. How large should the expansion tank be for a hot water heating system of 50,000 sq. ft. radiating surface with 1.7 pints of water per sq. ft. and the expansion of water taken at .00043 per degree, coefficient of linear expansion of iron .0000062?

14. Describe a vacuum heating system naming all the important auxiliaries and describe their uses.

15. Describe fully some form of hydraulic or electric elevator, with which you are familiar, including safety devices operation and controller.

16. Draw a diagram of the wiring of a modern electric elevator.

17. What improvements have been made in electric lighting machinery?

18. Describe fully and draw a diagram of a 3-wire lighting system, dynamo, switchboard, distribution tablets, and method of balancing the load. Why is a balancing apparatus essential?

19. Describe with sketch a compound dynamo.

20. Describe 2 ways of reversing the direction of rotation of a shunt motor.

21. How does the rheostat in the shunt field circuit of a dynamo change the voltage?

22. Draw a diagram of 2 direct current dynamos running in parallel and describe fully each step taken in putting one machine into commission with one running, also in shutting down one machine.

23. Describe the method of testing the insulating resistance of a circuit by the use of a volt meter. What is the resistance of a circuit, voltage 235, resistance of volt meter 19,000 ohms with voltmeter reaching 4.6 volts?

24. Describe and draw a sketch of the multiple 110 volt arc lamp. What is the voltage across the arc? How

does the flaming arc lamp differ from the above lamp?

25. What is the proper size wire (in circular mils) for 60 16-cp. incandescent lamps at 3½ w. p. c. located 500 ft. from the switchboard, resistance of pure copper wire 10.8 ohms per mil ft., drop in voltage 5 per cent?

26. What is the Gem, Mazda, and Holophane in electric lighting?

27. How does an unbalanced load on a 3-wire system affect the lamps? J. C. H.

Trouble with Engine

HEREWITH is a sketch of the piping in the plant where I am employed. We have 2 4-valve engines and 2 water-tube boilers. Engine No. 2 draws water and plenty of it; engine No. 1 has dry steam. Why is

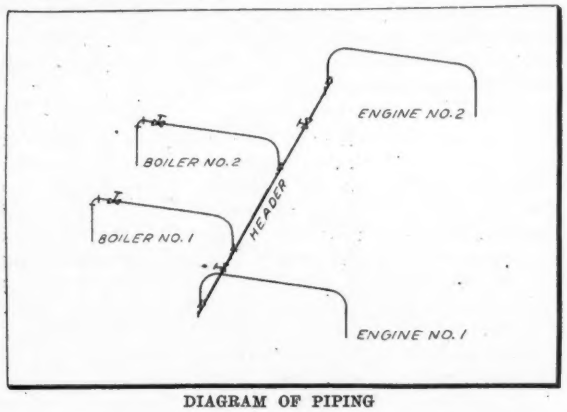


DIAGRAM OF PIPING

it that it makes no difference whether No. 2 engine is run singly or with No. 1 the water comes just the same? Neither does it seem to matter much whether the load is heavy or medium. There is no water drawn on light load. R. C. Havenhill.

Answers to Boiler Questions

I WISH to submit the following answers to questions by H. C. in Aug. 1 issue of Practical Engineer, page 795. There isn't any unbalanced pressure in the problem in hand. The effective area on either side of the valve disk is the same, and the difference between the weight of the check valve disk, and the weight of an equal volume of the water and the amount of friction produced by the disk and its guiding stem or spindle, when the disk starts to move, equals the number of pounds above boiler pressure which your pump will have to exert in order to open the check valve.

(The above answer is subject to criticism and readers are invited to discuss the problem in the columns of Practical Engineer. Some valuable help may be secured in the answer given by Mr. Fischer on page 971 of the Oct. 1 issue—Editor.)

2. They are usually secured by means of nuts and washers, or reinforcing plates which in turn are sometimes riveted to the plate to be stayed; a nut and washer on both sides of the plate is usually the practice, the washer being of a soft material, usually copper, fills in under the pressure of the nuts, which prevents breakage.

3. Babcock and Wilcox, Root, Cahall, Mumford, Geary, E. Keeler Co.

4. It does not provide cushion as does the fibrous gasket, besides in time it will squeeze out from between the surfaces, necessitating screwing up on the end bolts frequently, or anyway when the boiler pressure is taken off, otherwise the weight of the plate is liable to cause it to back up and tend to fall out of its place, thus opening the joint; with the fibrous gasket a firmer joint is secured.

5. Because a blowoff pipe 2½ in. in diameter is large enough for any boiler. A larger pipe may be used, however, if desired, since there are blowoff cocks on the market for a larger size of pipe. But the larger the blowoff pipe is, the more cautious one should be in blowing his boilers while under steam.

6. The uncertainty of the action of the larger valve for high lifts makes it undesirable on account of the limited diameter, 2 valves are thereby made necessary, whereas one valve formerly could be made to serve the purpose of 2 by giving the one valve which normally would be too small, an extra high lift.

7. By trial test the resistance of rivets in double shear have been found to average 1.85 times the resistance of rivets in single shear. This was proved at the Watertown Arsenal.

8. Because of the relative difference in shape, the shell is cylindrical and the tube sheet is flat. Then, too, the tube sheet being heavier or thicker, gives the tube ends more surface contact with the tube sheet, as the tubes are expanded in their respective places. This insures a more reliable joint than could be obtained if the tube-sheet were thinner.

9. The question is not clear. If by shell plate you mean the crown sheet of internally fired boilers, it would not be good practice to use diagonal stays in such a place because the direction of the forces to be controlled by the stay would be almost at right angles with the axis of the stay in any position or place you could place it, consequently a diagonal stay to support the plate would be excluded from use by its own weight.

10. There are no disadvantages to the use of brass blowoff pipes except that of first cost. T. C. Robinson.

A CRITICISM

EDITORIALS written with a practical object in view are highly to be commended, but I take the liberty of criticising the article on "Rubber Covered" in the September 15 issue, page 955. This is an example of the most extreme carelessness in not providing proper protection and safeguard for the electrical appliances of which the engineer was in charge. It is gross carelessness that a short circuit on a lamp cord should be able to throw the belt from the generator, because no protection was provided on the circuit, and the man's position should immediately be vacant. In the present days engineers are up and doing and should know that all parts of the plant are right as well as the engine, and should devote their time to more scientific matters than to "sit around and smoke."

Signed, C. Lampk.

(Mr. Lampk does not seem to have caught the thought of the article referred to, which was a criticism of the ignorance of the man making the short circuit, as well as of the carelessness which permitted the substitution of copper wires for fuses. But we feel that his objection to the engineer who should not make sure that his circuits were properly protected, is well founded; only we happen to know that such things do occur in plants where the engineer is active and conscientious and tries to have everything in shape; simply from the sometimes willful meddling of other men about the plant with the safety devices on electrical circuits.)

SMOKE ABATEMENT

As Discussed by the American Society of Mechanical Engineers, Oct. 8, 1912

By Geo. F. Bateman

H. R. COBLEIGH, of the meetings committee, called the gathering to order and introduced Geo. H. Perkins, who gave a report on the Smoke abatement Exhibition held last March in London, Eng.

Mr. Perkins spoke of the aid the Society can render in solving the economic and sanitary problems, and of the work of voluntary societies in England and Europe, the most important of which is in Hamburg.

This society is entirely different from others in that it is a voluntary organization of boiler users, whose object is to obtain greater efficiency and less smoke from their boilers. To do this their boilers are under the control of the technically trained engineers of the society who make and publish the tests thereon.

The society numbers 436 members, representing 1381 boilers, the annual dues being $5 per member, with an additional $5 for each boiler owned. It is interesting to note that the society is entirely self supporting, deriving its funds from 3 sources, viz., annual dues, payment for special work or reports, and payments for outside work.

In conclusion, Mr. Perkins gave the following factors necessary to be considered for the efficient, hence, smokeless combustion of coal.

1. Selection of a suitable fuel with provision for maintaining it at a fixed standard of heat value.
2. Careful study of the conditions prevailing in the plant, including draft, composition of gases, temperature, etc.
3. Design or selection of type of furnace or apparatus best adapted to meet these conditions.
4. Proper construction or installation of the furnace.
5. Careful selection of operating force.
6. Suitable instrumental aids or guides for the fireman or responsible engineer.
7. Frequent and thorough inspection to insure maintenance of highest possible efficiency.

Paul P. Bird, of the Commonwealth Edison Co., Chicago, was called on to open the discussion. He spoke of the smoke conditions existing in Chicago, and of the work being done by the city in analyzing the present problem and in examining plans for new boiler installations, the city's endorsement of which is necessary before actual construction is commenced.

O. P. Hood, Chief Mechanical Engineer of the Bureau of Mines, Washington, D. C., reviewed the situation and spoke of the work of the Bureau of Mines on the subject.

The part which gas producers, internal combustion engines, and the briquetting of coal will have in suppressing the smoke nuisance is small, he thought, and that we must turn to the proper design of our boiler furnaces to enable us to burn our fuel and the evolved gases to the full extent. He endorsed the action of large corporations and of the cities in studying the smoke problem and especially in the examination of the designs for new boiler plants. Our small villages should have the benefit of such examinations, for these villages rapidly become towns, and the towns develop into cities, with the result that by the time the community is able to establish an examining board, it is also confronted with the problem of old plants of faulty design.

Lt. James Reed, Jr., U. S. N., Ass't Director of Public Works, Philadelphia, spoke of the work of that city on the subject, and of the co-operation which they have had from the railroads. Chiefly anthracite coal is burned in Philadelphia, but some time ago, in view of a possible strike, the manufacturers began to store large quantities of such bituminous coal as they could obtain, with the result that although they did not eventually need it, when they came to get rid of it by actually using it, their efficiency as smoke producers was greatly increased. A suitable ordinance was, therefore, passed to suppress the nuisance.

Professor L. P. Breckenridge, of Yale University, spoke of the difference in the conditions of different cities. In New York there is really no smoke nuisance compared to Chicago, for instance, where 40 per cent of the smoke is made by the railroads. In New York there are no steam railroads coming into the city now. He commented on the enormous consumption of hard coal in this country, which was quite large enough without cities and legislatures compelling every manufacturer to use it. He wanted hard coal for his stoves at home and the price was quite high enough! Let the manufacturers use soft coal.

It has been conclusively proved that soft coal can be burned without smoke, and to do this, proper design of the furnace is necessary. For this, a knowledge of the kind of coal is also necessary with respect to the amount of volatile matter in it, and also of the rate at which the coal is to be burned. Another thing which is necessary for the proper burning of coal is the education of the fireman.

Speaking of his experience on the subject of smoke abatement, Prof. Breckenridge stated that recently he had been consulted by the New Haven Chamber of Commerce, which thought that railroads were making too much smoke at that place, and that they should be electrified. But, he asked them, was it fair to make only the railroads electrify? Let them electrify their city. Electricity was quite cheap enough nowadays, in fact, he knew of nothing in the vegetable line which has come down so much in price during the last few years as has electricity!

In concluding, he asked what was to be done with our old boilers. The problem of smoke abatement from them might be solved by the proper blending of different kinds of coals, as it is found that under proper firing this proper blending will produce smokeless combustion.

A. A. Cary, Consulting Mechanical Engineer of New York City, gave a very complete discussion of all the actions taking place in the boiler furnace. Dividing smoke into two parts—the more or less incomplete gaseous products of combustion, and the solid matter ejected, he thought the latter was caused entirely by the chilling actions occurring in the furnace. To prevent these chilling actions was the problem of the designer. Smokeless combustion, in the narrow sense of the word, is entirely possible in the use of soft coal.

G. L. Prentice advocated the licensing of fireman in a manner similar to that in vogue in Europe, after

proper instruction and examination. He spoke of the advantages of this in respect to the increase in wage and intelligence of the fireman.

Wm. Kent stated that a person beginning the study of law is given the problem of the "cracked basin." A man borrowed a basin and when he returned it, the owner found it to be cracked.

The borrower's statement was, first, that he had not borrowed the basin; second, that the basin was whole when he returned it; third, that it was cracked when he borrowed it.

The speaker said the defence of a plant against which he had been called as witness was something similar. They said that they were not making smoke; that they were spending large sums of money to prevent making smoke; and, finally, that they were not making much smoke.

Smokeless combustion of soft coal is entirely possible, as has been shown by Professor Breckenridge in Bulletin No. 15 of the University of Illinois, entitled "How to Burn Illinois Coal Without Smoke." He recommended this paper to all interested in the subject.

Proper design of the furnace is necessary, a case of a 600-hp. boiler being recited, which under forced conditions was cut down to 400-hp., on account of the choking of the air supply.

Prof. D. S. Jacobus, consulting engineer of the Babcock & Wilcox Co., spoke of smokeless combustion being possible only under normal conditions. In his opinion, smoke could not be prevented, say in case of a peak load coming on earlier than was expected.

To sum up the meeting, smokeless combustion of soft coal can be completely obtained by proper study of conditions and subsequent proper design of furnace, aided by the education of the firemen, mechanical stokers, and the proper blending of coal.

CONVENTION OF THE I. A. P. S.

THE seventh annual convention of the International Association for the Prevention of Smoke was held at Indianapolis, Indiana, September 25, 26 and 27, 1912. There was a representative gathering; 13 cities were represented by officials who devote their whole time to the smoke problems presented in their home communities. These representatives were gathered from Toronto, Canada, on the north, St. Louis, Mo., on the south, Newark, N. J., on the east, and Minneapolis, Minn., on the west.

Besides the city officials there were many representatives of various railroads present and there was a special interest taken in the discussion of the railroad situation as related to the abatement of smoke. It was stated that a locomotive fitted with a brick arch, steam jets on the side of the firebox, with a good blower in the stack and properly drafted could easily be operated without emitting dense smoke. Representatives of railroads entering Chicago, who spoke, stated that practically all of their engines are equipped as above mentioned and that by having high class men out on the road as traveling firemen and smoke inspectors, the railroad smoke had, within 4 yr., been reduced over 400 per cent.

W. C. Corning, Chief Smoke Inspector of the Chicago & Northwestern Railroad, stated that in his opinion the present movement among railroad men toward fuel efficiency would materially aid in smoke abatement; he gave figures which showed that under the same conditions a fireman had reduced his coal consumption, per run, more than 20 per cent, and that with the additional care used there had been no objectionable smoke.

Joseph A. Beck of Pittsburgh, described the work the University of Pittsburgh is doing by investigating the influence smoke has upon the health, bacteria, eyes, lungs, etc., and the effect that it has upon the cost of decorating, cleaning, lighting, etc. He stated also that considerable effort is being made to gather data pertaining to legal and mechanical means that have been adopted for smoke abatement. The University expects to have its report ready for publication sometime in the Fall of 1913.

E. P. Roberts, Chief Smoke Inspector, Cleveland, Ohio, exhibited a modification of the Ringelmann chart for grading smoke densities, which he proposes to have made up and to supply them to interested parties at cost. Mr. Roberts' chart is made in circular form on a white card about 4 in. in diameter. Starting on a circular line about ¾ in. from the center of the card, radial black lines are drawn 1 in. long; these radial lines cover a certain percentage of the area of the paper between the circles described at the inner and outer ends of these radial lines. By mounting the card and spinning it a shade of color is produced that corresponds to the smoke density, depending upon the percentage of white paper that has been covered up by the black ink.

At an informal dinner tendered by the Commercial Club of Indianapodis to those in attendance at the convention, a number of the prominent manufacturers of that city told of their experiences in improving their boiler equipment so that they could operate without being a nuisance to the community. These men said that when the smoke ordinance was first passed in Indianapolis in 1904, they were bitterly opposed to it, but since fixing up their plants they would not return to the old conditions, as they were making considerable saving in money.

J. R. Brown, Chief Smoke Inspector, Indianapolis, Indiana, was elected president for the ensuing year. J. M. Searle, Chief Smoke Inspector, Pittsburgh, Pa., was elected Vice-President. John Krause, City Treasurer, Cleveland, Ohio, was made Secretary and Treasurer.

The next meeting of the International Association for the Prevention of Smoke will be held at Pittsburgh, Pa., September 10, 11 and 12, 1913.

R. C. Harris, formerly Smoke Inspector of Toronto, Canada, who had been secretary and treasurer since the organiation of the International Association for the Prevention of Smoke presented his resignation of that office stating that his new duties would not permit him to attend properly to the work connected with that position. Mr. Harris has from the first been one of the most prominent and active workers in the association and in token of esteem his fellow members elected him to Honorary Membership and presented him with a silver dish.

The ladies of the convention were entertained by Mrs. John M. Juda, President of the Ladies Smoke Abatement League of Indianapolis, by automobile trips, trolley rides and many other courtesies.

WHEN USING a new file, especially in the lathe, it is sometimes found to scratch and produce an undesirable finish. This can be obviated by taking an oilstone and rubbing it over those parts of the file which are doing the scratching.—Penberthy Engineer and Fireman.

FOREIGN INVESTIGATION AND DEVELOPMENT IN THE POWER PLANT FIELD

The Working of Turbines with a Condenser Vacuum Greater Than That for Which They Have Been Constructed

TRANSLATED BY J. H. BLAKEY

IT may happen, in an installation of turbines, that the conditions become such, after putting the machines into service, that it is possible to obtain a greater vacuum in the condenser; in such a case it may be asked whether, with the turbines installed, there is any real advantage in increasing this vacuum, or whether the internal friction resulting from the increased speed of the steam following the augmentation of the depression in the condenser, does not entirely absorb the extra energy produced, and consequently annul the benefits of the lowering of the vacuum pressure.

In the Zeits des Ver deutsch. Ingen., of June 22, M. Loessel gives the results of experiments made upon an installation of 2 Zoelly turbines of 500 hp., in service at the mines of Brux, Bohemia, which has been designed to work with a condenser vacuum of 90 per cent, which was reduced to 96 per cent, the other conditions of load, temperature and pressure of the superheated steam, etc. remaining the same, as nearly as possible.

The author concludes from these experiments that the increase in the vacuum was entirely utilized in the 2 turbines tested, that the heat energy in relation to the condition of the steam entering the turbine did not diminish, even with the greater of the 2 depressions studied; and finally that it is in the last 2 degrees expansion in the turbine that the increase of power due to the greater vacuum is developed.

CORROSION OF STEEL IN WATER

IN the Journal of the Royal Society of New South Wales, Messrs. Burrows and Fawsitt discuss this subject. The authors believe that the first stage of rusting is the solution, to a limited extent, of iron in water, with the formation of ferrous ions. The hydrogen so produced, in the absence of free oxygen, polarizes the iron surface; the function of oxygen is then the removal of the layer of polarizing hydrogen. If this is so, contact with a more electronegative metal, like platinum, should increase the velocity of rusting. Experiments made to test this, using uniform steel strips fully immersed in unstirred distilled water, showed that such strips when connected with platinum rusted more rapidly than in ordinary circumstances. The steel used had the composition: C, 0.35 per cent; Mn, 0.61 per cent; P, 0.06 per cent; Si, 0.01 per cent and S, 0.01 per cent.

Experiments to test the influence of the composition of steel on the velocity of rusting in water gave irregular results, from which no exact conclusions could be drawn. It was noticeable, however, that the initial rate of corrosion was very different from the rate which sets in after a few weeks, and that a steel containing about 10 per cent of carbon rusts less than steels containing a smaller per cent of carbon.

Magnetization has no noticeable effect upon the corrosion of a steel of the composition given above. In discussing the work of Heyn and Bauer on corrosion, the authors state that the accelerative effect of salts on corrosion is explained by the greater conducting power of the solution, and that the decrease in the velocity of rusting with higher concentrations is probably due to the decreased solubility of oxygen in the solution.

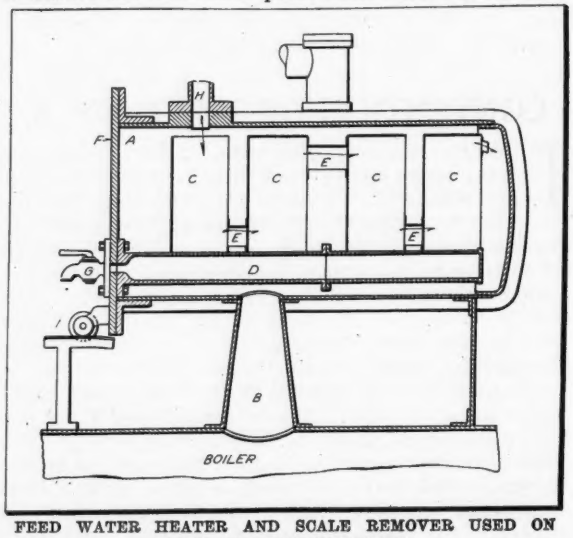
HEATER AND SCALE REMOVER

Type of Apparatus Used on Hungarian Locomotives

THE calcareous salts contained in the feed water of locomotive boilers are deposited in the form of mud and incrustations which must be removed periodically, seldom without damage to the metallic walls, because their presence impedes the transmission of heat and causes considerable danger of explosions.

To avoid these deposits, a small quantity of carbonate of soda is often added to the feed water; this prevents the formation of a very adherent crust, but cannot in any case entirely eliminate the formation of mud or even of solid deposit.

With the use of the water heater and scale remover shown in the accompanying illustration, the use of soda is unnecessary. The action of the apparatus is purely physical, in the sense that it precipitates the salts of lime by simple reheating of the water, and that it allows the mud to deposit itself elsewhere than in the boiler; finally, by retaining the mud and salts it delivers to the boiler feed water which is almost entirely free from materials of incrustation. The apparatus consists of a cylinder A fixed upon the boiler by means of an upright boiler tube B.



FEED WATER HEATER AND SCALE REMOVER USED ON HUNGARIAN LOCOMOTIVES

In the interior of the cylinder are a number of vertical chambers C, communicating with each other alternately at top and bottom by means of passages E of large diameter. These vertical chambers are all connected by a horizontal tube D, into which each of them opens. This collector D is furnished with a cock G, so that it may be emptied when necessary.

The vertical chambers and the collector are attached to the front cover of the cylinder A, so that the whole arrangement can be removed for cleaning when the fires are out. The cover moves to the left, as shown in the drawing, and rides upon a rail attached to the top of the boiler, by means of the rollers I.

The feed water enters the apparatus through the tube H, and falls into the first chamber C, and flowing slowly from one to another escapes finally by the overflow from the fourth into the cylinder, and thence by the passage B into the boiler.

During its passage through the chambers the water is heated by the steam in the cylinder, which has free circulation around the chambers; it therefore gradually releases its calcareous salts, which fall into the collector D, where, the water being perfectly calm and without current, they are deposited in the form of a crust which is soft and easily detached by means of a jet of water. The mud is allowed to escape at intervals by means of the cock G.

This apparatus, which is in regular service on the locomotives of the Hungarian railroads, increases from 5 to 10 times the length of the intervals between 2 successive cleanings of the boilers. In addition the deposits in the boilers fitted with it are found to have a leaf-like formation, and are easily removed by a jet of water, so that the cleaning does not injure the boiler plates; finally, the feed water entering the boiler hot does not produce those local fluctuations of temperature which are often the cause of leakage of the feed water pipes at their point of insertion into the tubular plates.

MEASUREMENT OF BELT SLIP AND POWER LOSS

By W. F. Schaphorst

NO belt should ever be allowed to slip. Slip is a most unnecessary evil and wherever it does occur it can invariably be stopped by proper selection and treatment of the belting and pulleys. That proper care and selection of belts are essential to the elimination of slip is proved in innumerable practical and even theoretical articles on belts that have been published in years past. That pulley

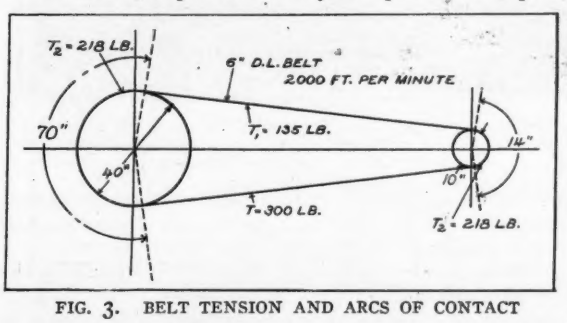


FIG. 3. BELT TENSION AND ARCS OF CONTACT

selection has to do with slip is proved in articles published just recently. The best combination of belt and pulleys for the total avoidance of slip is the thing to seek.

This comment is incited by an article in the December 1911 issue of Practical Engineer which article is there accedited to The Phoenix. The most radical assertion in that article is this: "Some slip is necessary, since without it there is no friction between the belt and pulley and no power can be transmitted." If it seems to contain some underlying logic let us go back to the first fundamentals in the study of friction and find out.

In Fig. 1, W is a weight resting on, say, a smooth horizontal plank and F is a force "just large enough" to drag it along the surface of that plank. The coefficient of friction, usually designated by u is then equal to F÷W. If force F acts through a distance d, the mechanical energy required is F × d. This, as The Phoenix correctly says, becomes heat, but, no useful work is done. Thus, if we make F equal to 1000 lb. and if the weight is dragged 33 ft. per minute, 33,000 foot pounds (1 hp.) would be "lost" in that time.

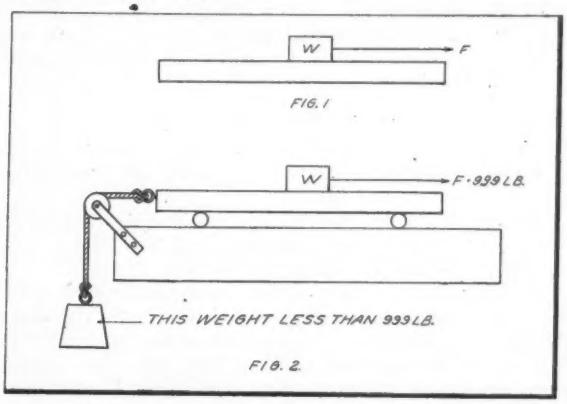


FIG. 1. SIMPLE FRICTION DIAGRAM
FIG. 2. FRICTION OF WEIGHT ON BOARD BALANCED BY SUSPENDED WEIGHT

Now, 999 lb. would not move the weight at all; it requires at least 1000 lb. A 999-lb. force could therefore be considered "safe." Thus, by placing the plank on rollers as indicated in Fig. 2 and rigging an apparatus as shown, the friction between the weight W and the plank could support the suspended weight of 999 lb. Pull slowly and any weight less than 999 lb. could be lifted and useful work could then be performed. In other words, power can be transmitted without slip contrary to the quotation above. The successful operation of belts and pulleys is based on the same principle but involves more factors, namely, arc of contact, width and thickness of belt, pliability, speed, and initial tension.

Slip Measurement

FURTHER, the author of the article from The Phoenix measured slip with reference to the velocity of the belt. That is incorrect. Slip must be measured with reference to the velocity of the rim of the driving pulley. The percentage of slip may be obtained in this way:

Velocity of rim of driving pulley minus velocity of rim of driven pulley divided by velocity of rim of driving pulley equals per cent of slip.

The Phoenix uses as an example a 6-in. double leather belt running 2000 ft. a min., delivering 10 hp. to a line shaft. The tension on the tight side is 300 lb.; tension on slack side 135 lb., see Fig 3.

$T - T_1 = 300 - 135 = 165$ lb., the working force comparable to our 999 lb. in Fig. 2.

The slip on the driving pulley, they say, is 6 per cent; on the driven pulley, 4 per cent. Let us check the figures:

$$\text{Hp.} = \frac{(T - T_1) \times \text{Vel. of belt per min.}}{33000} = \frac{165 \times 2000}{33000} = 10$$

Now, if the slip on the driven pulley is 4 per cent,

how can 10 hp. be delivered to the line shaft? It is impossible.

10 hp.—(4 per cent of 10 hp.)=9.6 hp. actually delivered.

The velocity of the driven pulley is 2000—(0.04×2000)=1920 ft. per min.

The slip on the driving pulley being 6 per cent, let V=velocity of the rim of the driving pulley. Then, V—(0.06×V)=0.94V=2000 ft. a min., the given velocity of the belt.

Solving, V=2000÷0.94=2128 ft. a second.

2128—2000=128 ft. slip on the driving pulley instead of 120 as stated in the article.

Now, to find the actual percentage of slip in his own arrangement, Fig. 3, by applying the rule above we get 2128—1920÷2128=0.0977=9.77 per cent slip.

Power Loss

TO find the horsepower required of the motor under these conditions we use practically the same process: 10÷0.94=10.64 hp.

Above we found that 9.6 hp. are actually delivered to the line shaft. Therefore, 10.64—9.6=1.04 hp. lost instead of ⅞ hp. as computed by The Phoenix.

It has recently been shown analytically that each per cent of slip in a belt represents practically the same per cent of power loss. That method has been used in this article throughout. Thus 10.64 hp. (the power given up by the above motor) multiplied by 9.77 per cent (the percentage of slip of the above belt) gives 1.04 hp. lost. This necessarily checks with the calculation already made.

Creep

SINCE all belts are more or less elastic they must creep. This may be readily determined by taking the speed of driving and driven pulleys simultaneously, when the belt is pulling full load with apparently no slip. Compute the speed which the driven pulley "should have" had. The computed speed will invariably be higher than the actual speed. The difference is a measure of the creep. Unhappily, this term is often used interchangeably with slip even in our best engineering magazines. The difference between slip and creep is this: slip is avoidable; creep is unavoidable.

It is customary to allow 1½ per cent for creep. Then, to compute the avoidable power loss in the above example, 9.77—1.5=8.27, the percentage of preventable slip.

10.64×0.0827=0.881 hp., avoidable loss.

Now, if the current for running the above motor costs 3 cents per hp.-hr.; if the motor is operated 8 hr. a day; and 300 days each year, the avoidable money loss becomes .03×0.881×8×300=$63.43 per year.

To give a belt proper care is surely worth while if such enormous losses accrue by allowing a small 10 hp. motor belt to slip.

It is not the intention of the writer to ridicule the article taken from The Phoenix. The method I use is new, so far as I know, and it may contain some slight flaws of which I am not aware. Any criticism will be relished. Although errors were made in computations, the Phoenix method is plainly a sound and rational development. It is, however, much more cumbersome than the "one per cent slip one per cent loss" method. It will be noted that The Phoenix obtains ⅞ hp. (0.875 hp.) for the "power loss." My calculation gives 0.881 hp. "avoidable loss." The fact that they so nearly coincide in this case means nothing, it is purely accidental.

SAVING CONDENSATION

Special Trap System Which Utilizes All Vapor and Returns Condensation Automatically to the Boiler

AT the Saltpeter Works of Battelle & Renwich, Jersey City, N. J., a novel steam trap system has just been started up, which takes care of all condensation from all the apparatus throughout the mill and returns it to the boilers.

Not only does this system take care of all condensation, but it is so arranged that the waste vapor from the vents of the traps is condensed and returned with the regular condensation.

The mill apparatus consists of 19 special kettles for boiling, each kettle being equipped with what is known as a pit coil, that is, the drip from the coil instead of passing through the bottom of the kettle is carried

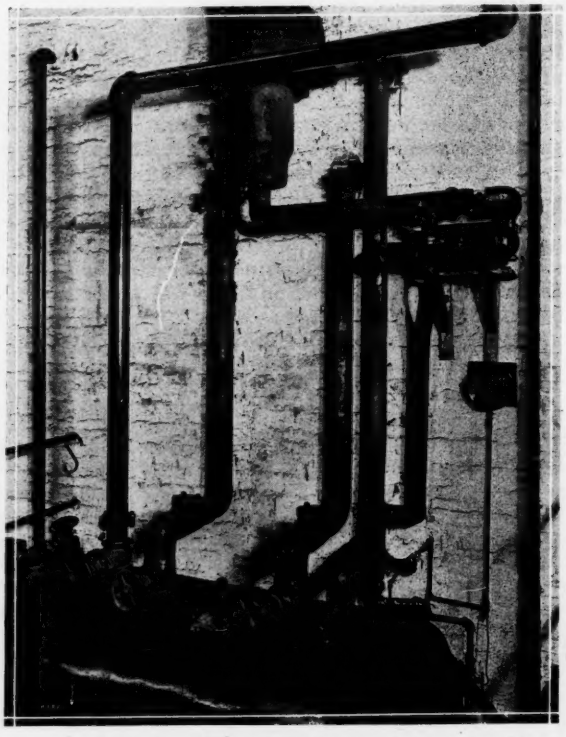


FIG. 3. RECEIVING TANK IN BOILER ROOM FOR RETURN CONDENSATION

up over the edge, so that the water of condensation is raised 6 ft. before it is discharged. A dry room and drying machines are also included in the system.

The approximate amount of steam required for the boiling alone amounts to about 600 hp. The boiling point of some of the liquids in the kettles is as high as 270 deg. F.; therefore, live steam is required for this work. On account of the nature of the boils it has been impossible to use ordinary traps on this work, but each coil at the present time is equipped with a Special No. 20 Lytton trap, Fig. 1, which discharges into one of the return mains, of which 2 are used, running through the factory and back to a receiving tank in the boiler room. The temperature of this return water varies from 260 to as high as 300 deg.

All vapor from these special traps is used for drying purposes and when condensed is also returned to

the boilers, so that no steam or vapor is allowed to blow into the atmosphere.

On the boilers are located 2 4-in. return traps and one 1½-in. return trap, Fig. 2, which take care of the return water from the factory at the temperatures mentioned and return it automatically to the boilers. Those at the end are 4-in. traps, for the bulk of the condensation; the one in the middle is 1½-in. to care for apparatus on the first floor.

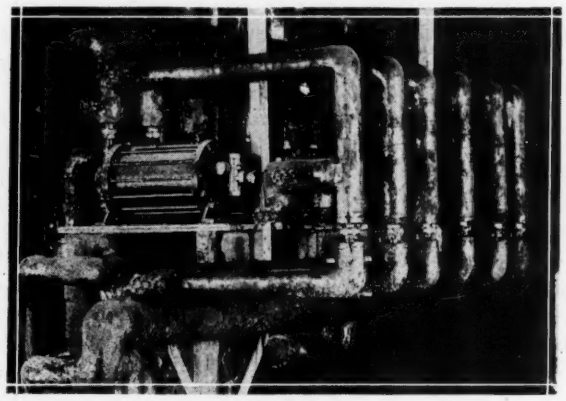


FIG. 1. BATTERY OF 6 TRAPS TO DRAIN BOILING KETTLES AND PASS CONDENSATION TO RETURN MAINS

Condensation from the live steam mains is also trapped and collected in a separate return which discharges into the receiver in the boiler room. Reading from the left side of the cut, the third pipe with a check valve in it brings the condensation from 8 kettles in the mill, the next one to it brings the condensation from 10 kettles in the mill to the receiver and the next pipe is the return for all the traps on the live steam line. One of the No. 20 traps, draining the receiver and boiler room system, is shown discharging into this line. The steam gage shows a pressure of about 35 lb., which is due to the re-evaporation of the condensed water from the mill. From the bottom of this receiver or hot well a 4-in. pipe is carried up to the traps on the boilers. This receiver is also arranged so that in case the traps are shut down cold water can be injected into it, the vent pipe opened to the atmosphere and a pump used for handling the water.

By the installation of this system the saving in coal alone amounts to 2.5 tons a day, while the boiling capacity of quite a number of the kettles is increased from 15 to 25 per cent. It has not only made a saving in coal and increased the capacity of the kettles, but it is feeding the boilers with about 90 per cent of pure water which prevents the formation of scale and dirt and also makes an additional saving in the amount of extra water that would have to be purchased from the city.

This system was devised by D. J. Lewis, Jr., sales manager and trap expert of the Lytton Manufacturing Corporation, and consists of 26 Lytton traps, 3 of which are return traps and the balance regular and special 20 Series traps.

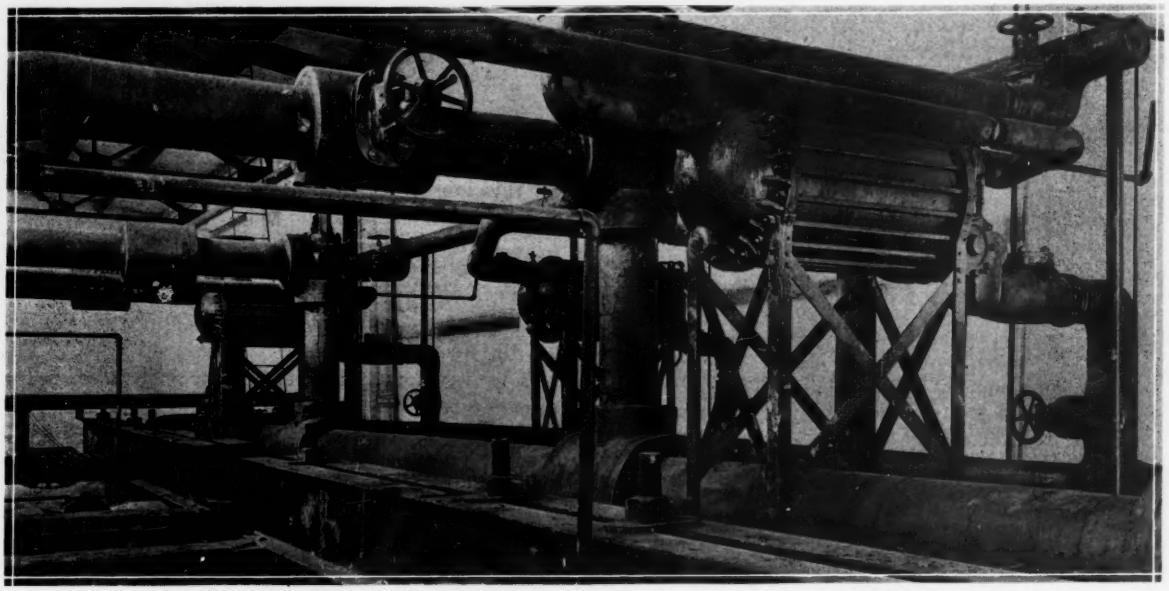


FIG. 2. RETURN TRAPS ON TOP OF THE BOILERS DISCHARGING INTO A COMMON HEADER

BUTTERED UP

ANNO Domini, 1952, was chalked up on the almanac, and the great Eastern flyplane express was skimming along in its midnight journey from London to Pekin.

Suddenly the mechanical dicky-bird found itself in difficulties among the stars. Something was visibly wrong with the engine, and the customary speed palpably slackened.

"Ga-hoodness!" cried the skipper, glancing astern at the vibrating propellers. "We're a quarter of a second late! What ails the engine? What makes her go so slowly?"

The befoggled, perspiring engineer hopped from his perch and faced the commander, with tears in his eyes,

"Sir," he remarked sagely, "we're passing through the milky way, and the propellers are full of butter!"

And the skipper, being a great astronomer, let it go at that.—The New England Engineer.

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COALING UP FOR LIGHT LOAD

Getting proper combustion is always a matter of interest to everybody around the power plant, from the woman whose wash hangs next door, to the stockholder who is looking for dividends. But neither of these can do much towards getting proper combustion. Committees and conventions may arouse public sentiment against smoke, and owners may demand the economy of perfect combustion, but somebody, right in the plant, has got to solve the problem of what conditions are to be maintained in that particular plant, in order to get the best efficiency.

Assistance may come from a well posted inspector who takes the sensible view that it is better to help find how to stop the smoke than to prosecute for not stopping it. But after the "how" is known it is "up to" the station staff to keep up the desired conditions.

General principles are the same everywhere and are easily understood, but just how to apply them to a given plant is often a puzzling question. Proper amount of air supply seems to be one point on which "doctors disagree." There must be enough air, but not too much; and as the small boy said about the apples, "too much is when you don't want all you've had."

Evenly covered grates and regulated draft seem the best means of control, with provision for extra supply above the fire for a short period after coaling. When load falls off, the tendency is to lighten the fire and cut down the draft, with consequent tendency to burn holes and give excess of air. A method suggested in a recent discussion seems to have advantages that make it worth trying. When the load lightens, thicken the fire, keeping the draft about as before. The heavier fuel bed, by its increased resistance, will cut down the air supply, hence the rate of burning, and will maintain a large body of fuel, ready to break out and force, if sudden increase of load occurs.

The difficulty which seems probable is the reducing of air in proportion to fuel so as to cause smoke, but this might be avoided in hand firing by building up somewhat slowly, one side at a time, and slackening draft while doing it; with a chain grate, it could be accomplished by thickening the bed and reducing the speed of grate travel.

The suggestion would seem to apply particularly well to furnaces designed for "delayed combustion." It is well understood that the extremely high firebox temperature maintained by a hanging combustion arch above the grate or by a tile roof furnace results in heavy repairs to the furnace and trying heat for the fireman whenever the fire doors are opened. In the delayed combustion, the air supplied above the fuel, either through side walls, jets or hollow bridge wall, is mixed with the gases and combustion completed by passing through checker work fire brick baffle walls in the combustion chamber.

In this way, intimate mixture of air and gases is insured, the zone of highest temperature is removed from the cooling influence of opening the doors, thus reducing unequal expansion strains, the fireman is

relieved of exposure to this high temperature and the large mass of fire brick stays at a temperature that will cause as nearly complete combustion as the proportions of air and gas supplied will permit, and with a less excess of air than is required where a high and even temperature of the combustion space is not maintained.

These conditions are certainly such as to be favorable to the thickened fire bed method for light loads and tend to ease of operation as well as high efficiency.

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By Arthur L. Rice, Treas.

A BOOST AT MINNEAPOLIS

Engineers Eat, Joke and Enthuse

ON Saturday evening, Sept. 28, at Hotel Radison, Minneapolis Association of Stationary Engineers, held the largest, most enthusiastic, and most successful booster meeting and banquet ever known. In addition to the Minneapolis members, St. Paul No. 7 came over in a body, and employers of various members were numerous as well as many leading citizens, making a total in attendance of close to 300.

The meeting was held in the ball room of the hotel, where a distinctly engineers' repast as set forth on the attached menu, was served.

Cylinder Oil (from tomatoes); Fibrous Packing (of celery); Governor Balls (olive type); Nut Coal (from the radish vein); Leather Belting (tenderloin brand); Ball Bearings (pea pod retainers); Boiler Compound (potato dope); Engineer's Special (Lettuce and Tomatos with oil); Sheet Packing (wafer thickness); Refrigeration (applied to cream); Pump Valves (badly caked); Rod Packing (in rolls); Condensation (black as coffee); Belt Dressing (in yellow squares); Valve Stems (took fire and smoked).

Following the eating event came the talkfest, presided over by Toastmaster J. F. Gould with his usual acceptable facility.

Speeches were made by Prof. J. J. Flather of the University of Minnesota on engineering matters in general. By National President J. F. McGrath of Chicago on the Aims and Objects of the Association. By J. A. A. Burnquist of St. Paul on Engineers' License Laws. By John W. Lane of Chicago on the National Engineers' Association. By W. L. Harris on Business Mechanics, an inspiring address which was followed by the turning in of 46 applications of new members to the association.

The other speakers were C. D. Gould, Minneapolis; J. B. Crane, Duluth; State President Herman Mueller, Minneapolis; State Vice-President James McGeary, St. Paul; State Secretary T. S. F. Hayes, St. Paul; State Deputy and President No. 2 Fred Camitsch, St. Paul, and J. M. Williams, Minneapolis.

The affair was a complete success and No. 2 confidently expects to have every engineer in the city enrolled in the near future.

PRACTICAL VENTILATION

By William J. Baldwin

BECAUSE of the impurities thrown off by the body, the excess of carbonic acid, moisture, and heat and the excessive percentage of bacteria in the air of a room where people are confined, it has been found that between 1500 and 2000 cu. ft. of air per person per hour is necessary, when doing light work. When windows are closed tight it is impossible to get a sufficient quantity of air into a room by leakage alone. If, however, the windows are fairly loose, it may be safe to say, that with not more than one occupant to each outside window, mechanical means of ventilation may be dispensed with, if the air is not vitiated except by respiration. The average leakage through an ordinary tight slide sash window is about 40 cu. ft. of air an hour per linear foot of sash crevice, in winter weather, so that a window 4 ft. wide by 8 ft. high, with slide sash will leak approximately 1200 cu. ft. of fresh air per hour.

If there are more occupants than one to each window, mechanical ventilation is invariably necessary, to maintain a proper standard of purity. It can be made a profitable investment to install a ventilating apparatus in any enclosure where a number of people are obliged to be confined in close proximity to each other, for any great length of time. A person can do more work and more effective work in an atmosphere of pure air than in one where the air is vitiated. Take an office with say 50 occupants and assume we supplied each occupant with 1500 to 2000 cu. ft. of fresh air an hour or a total of 75,000 to 100,000 cu. ft. of air per hour. The cost of moving this quantity of air by means of electrical driven fan the cost of warming the air in zero weather to 70 deg., plus the interest on the investment and wear and tear on the apparatus, would not exceed $1 a day in many cases. Making a total expenditure of say 2 cents a day a person as the cost of ventilation. Surely this must appeal to the thinking business man.

An employee is justified in expecting or demanding a healthy place to work in and it can be made a source of profit to the employer to provide such a place for his employees.

STATUS OF THE GAS PRODUCER.—The United States Bureau of Mines, Department of the Interior, has just published a technical paper on "The Status of the Gas Producer and of the Internal Combustion Engine in the Utilization of Fuels," by Robert Heywood Fernald. Tests of 2 kinds have been conducted at the government fuel-testing plants, first with the pressure producer, and second with the down-draft producer. A more detailed account of these investigations is given in Bulletin No. 15, recently issued by the bureau. The more important facts and conclusions given in that bulletin are summarized in the present one, known as Technical Paper No. 9.

The author states that a personal inspection of a large number of gas-producer installations warrants the conclusions that the plants as a rule are giving remarkable satisfaction, considering the brief period of development since this equipment was first introduced, and that, furthermore, the most serious difficulties seem to arise from a lack of thoroughly competent operators to run the plants, rather than from defects inherent in the plants themselves. The past year may be regarded as one of steady conservative progress and development in the field of the internal-combustion engine. Nearly 100 important gas-power problems are now under consideration by the Bureau of Mines as subjects for proposed investigations.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

NEW LINE OF BLOWERS

Specially Designed for High Speed and Direct Drive by Steam Turbines

FOR turbines driving pumps or blowers in power plant service, where the exhaust is used to heat feed water or for steam heating, with the exception of a slight loss through radiation, what heat is not converted into mechanical work is either returned to the boilers or utilized, so that the heat efficiency closely approaches 100 per cent.

As is well known, however, turbine power increases with the revolutions per minute up to a best speed that is invariably higher than that of ordinary turbine pumps or ordinary blowers. The writer has in mind a small steam turbine that develops 15 brake hp. at 1000 r.p.m. and 40 hp. at 3500 r.p.m., with the same pressure and total steam per hour. A larger turbine of another type develops 80 brake hp. at 600 r.p.m. and 160 brake hp. at 1600 r.p.m. with the same pressure and total steam per hour. The best pumps or blowers for these 2 turbines would therefore be the ones having economical speeds close to the higher turbine speed figures in each instance.

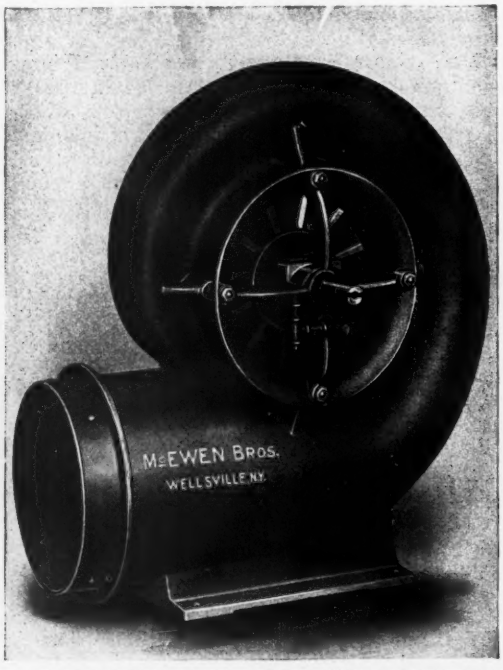


FIG. 1. 16-IN. McEWEN BROS. FORCED DRAFT BLOWER WITH HELICAL IMPELLERS AND SOLID CAST-IRON CASING

With these considerations in mind, C. V. Kerr, inventor of the original Kerr Turbine, has designed, and McEwen Bros., of Wellsville, N. Y., are now marketing a new line of pumps and blowers for turbine drive, having best speeds practically the same as those for the turbine and having an economical range within 25 per cent above to 25 per cent below rated capacity.

The McEwen Bros. blowers, as they are designated, are built in 2 types, the smaller sizes with double helical runners and the larger with increase pitch propellers. The manufacturers claim for both types a unit economy or steam per air horsepower better than ever reached before, especially on forced draft pressures. Both types have the runners opposed and balanced for high speed and have a central deflector to prevent cross flow. The runners are removable endwise and may be reversed on the shaft for right or left hand discharge. The bearings are lead-bronze, or babbitt lined, ring oiled and dust proof. The helical runner type has a solid cast-iron volute, and the propellor type is made with cast-iron sides and steel volutes.

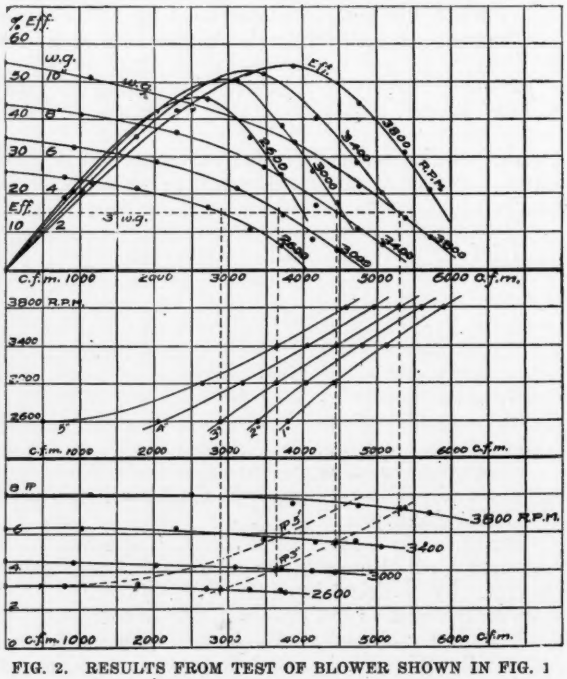


FIG. 2. RESULTS FROM TEST OF BLOWER SHOWN IN FIG. 1

The former, shown in Fig. 1, is designed especially for forced draft for forges and furnaces and in connection with underfeed stokers. Tests on a 16-in. blower of this type, and made with a calibrated steam turbine, Pitot tube and a series of nozzles showed the results indicated in Fig. 2.

The propeller type McEwen Bros. blower, shown in Fig. 3 and 4, has blades with an increase-pitch helical surface to reduce the shock losses due to impact at entrance. The kinetic efficiency of these blades is said to be high and in connection with the volute casing, reduces the discharge velocity to produce pressure instead of eddies which descrease the efficiency and delivery pressure of an ordinary disk fan.

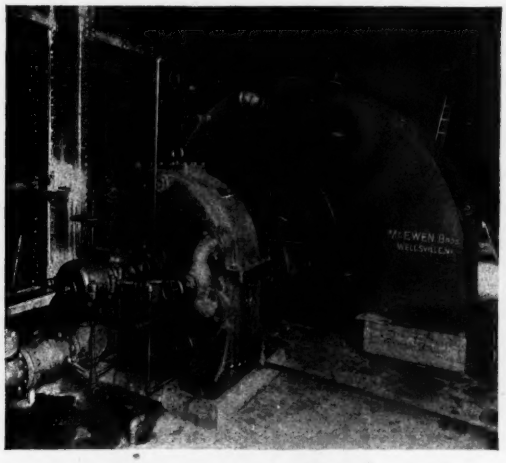


FIG. 3. PROPELLER TYPE McEWEN BROS. BLOWER, CAPACITY 80,000 CU. FT. OF AIR PER MIN. AT 4 IN. WATER PRESSURE

Losses from back flow are prevented and a strong construction assured by dovetailing the blades into a solid hub. It is evident too that as the pull of centrifugal force is radial there is practically no blade distortion at high speed. A peculiarity of this make of blower is the use of interchangeable wheels in the same casing, to produce different pressures for approximately the same speeds and capacities.

The performance of a blower of this type, the smallest of the series offered, is shown in Fig. 5.

These tests also were made with a calibrated turbine, Pitot tube and a series of nozzles at the end of a duct. The smoothness to which the points plot can be

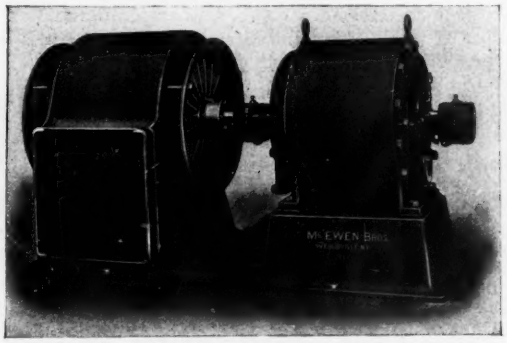


FIG. 4. 18-IN. PROPELLER BLOWER WITH KERR TURBINE DRIVE

taken as an indication of accuracy of observation. The relation of the parabola of highest efficiency, $Q^2=K\,H$, (in which Q=quality, H=head, K=constant) to the dot at the top of each efficiency curve located by the same nozzle in each case is worthy of note. This suggests that, if the discharge connection is reduced to the proper area, the blower can be operated always at highest efficiency, regardless of speed. Beyond this throat the duct should be expanded to reduce velocity losses.

The head or pressure curves show the facility with which a number of McEwen Bros. blowers can operate in parallel on the same duct, and how rapidly the discharge increases at contant head with increase of

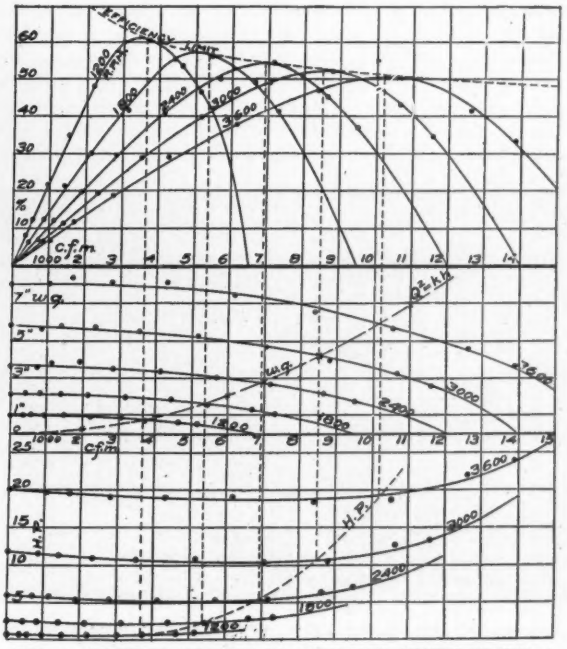


FIG. 5. RESULTS OF TEST OF 18-IN. FAN SHOWN IN FIG. 4

speed. The variation of power required as the blower is worked along the path of highest efficiency is also worthy of note.

Incidentally, the test results show that this blower, developed especially for forced draft work, is practical with either steam turbine or motor drive. On account of high efficiency and noiseless running at required pressures this blower is also useful for heating and ventilating service, including mine ventilation.

ATLAS ENGINE WORKS SOLD

THE Lyons-Atlas Co. has taken over the works, business and good will of the Atlas Engine Works of Indianapolis, and will continue and push the manufacture and sale of the Atlas-Diesel oil engine and of the Silent-Knight automobile engine of which they hold sole license to manufacture for the trade in the United States.

The price paid for the plant and business is stated at $1,500,000.

Officers of the new company are: President, James W. Lyons; Vice President, William P. Lyons, Secretary and Treasurer, George Lyons. This is an interesting case of a return to the old home as Messrs. J. W. Lyons and W. P. Lyons were employed in the Atlas Engine Works some 20 yr. ago, and now return to the plant as proprietors.

Frank Baker, who has been identified with the works in many responsible positions will act as assistant to the president under the new organization.

RECENT IMPROVEMENTS IN UEHLING CO_2 METERS

SEVERAL novel improvements have recently been introduced in the Uehling CO_2 machines and waste meters. To make a CO_2 meter of real value in a boiler room, it must be fool proof, and must operate without the attention or care of an expert. About 90 per cent of the repairs and attendance required to keep a CO_2 Recorder in first class condition, center around troubles due to the use of a caustic solution and the necessity for its removal, correction for errors due to its evaporation or changes in temperature and in short, because the presence of a solution makes an automatic CO_2 analyzer a rather complicated and delicate piece of

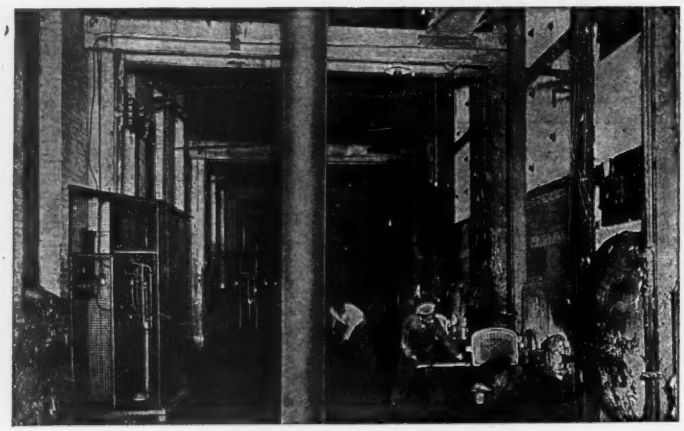


FIG. 1. BOILER PLANT USING UEHLING D C WASTE METERS

chemical apparatus. Thus it is logical to expect that elimination of the caustic solution would be a great improvement in CO_2 recorders. The use of any absorbent for CO_2, other than a liquid, would be impossible with any analyzer or CO_2 recorder in which the volumetric displacement of the caustic enters into the measurement of volume of gases.

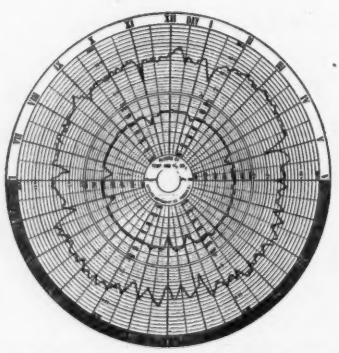


FIG. 3. UEHLING TYPE M RECORDER, GIVING A CHART OF CO_2 OR TEMPERATURE

FIG. 4. CHART FROM A TYPE D M UEHLING COMBINED CO_2 AND TEMPERATURE RECORDER

As the Uehling CO_2 machine, however, does not measure CO_2 by measurement of volume of samples of gas, but by a measurement of drop in pressure between 2 orifices where the CO_2 is removed, it is evident that a dry method of CO_2 absorption would be just as effective as the older or liquid method. Accordingly for some time past, investigations have been made in the laboratory of the Uehling Instrument Company, covering tests on different types of dry absorbent cartons with special reference to their adaptability for simple renewal and effectiveness under different operation conditions.

Experimental work was completed about a year ago, and since then, dry absorbers have been installed on practically every CO_2 machine out in service, and

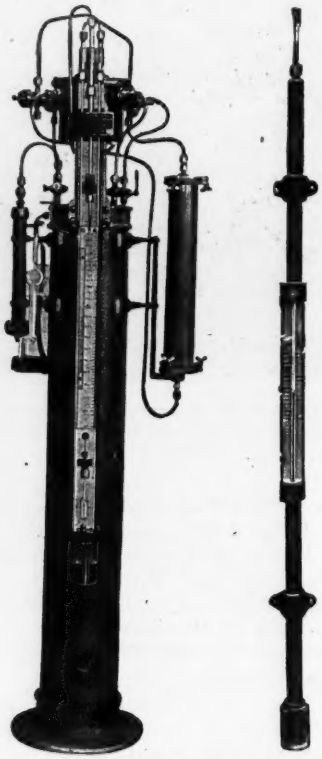


FIG. 2. UEHLING STYLE S C WASTE METER
FIG. 5. UEHLING TYPE Z CO_2 INDICATOR

have been furnished with all new equipments. An installation of this type, which is also provided with the new Type M recorder, further described below, is in the boiler plant of the Corn Products Refining Company, Edgewater, where all of the 24 boilers are equipped with Uehling Waste meters for measuring CO_2 and flue gas temperature, one boiler room being illustrated in Fig. 1.

Dry absorber cartons are cylindrical in shape about 3 in. in diameter and a foot and a half long, encased in a wax press board, so that they are handled, shipped and stored, like ordinary dry batteries, for instance. The absorbent is a specially manufactured flakey substance named natron, carefully packed in layers within the carton. The carton is placed in the cylindrical chamber at the right of the machine, shown in Fig. 2 which illustrates the style S C machine, the operation consisting simply in removing a few wing nuts, removing the used carton and inserting the new one.

Other improvements in connection with Uehling CO_2 meters center around the recording devices proper. The equipment consists of the machine in which the CO_2 is absorbed and the percentage measured pneumatically by changes in vacuum between 2

orifices, and then this vacuum is transferred to recorders or indicators situated where desired. The new Type M recorder is shown in Fig. 3. It is for service in connection with CO_2 meters or the pneumatic pyrometer (operating on a similar principle) or the Waste meter which measures both CO_2 and temperature. The Type M recorder is simply a light pressure or vacuum recorder for vacuums or pressures or both from 0 to 60 in. of water column. When this is supplied for recording CO_2, the chart is calibrated from 0 to 20 per cent CO_2, and when supplied for recording temperature, it is calibrated up to 1000 deg. or for other ranges as desired. This recorder supercedes a somewhat larger gage used in the past but operated on the same principle, viz: the U tube principle being filled with a special oil and involving no levers, pins, springs or similar devices.

In connection with Uehling Waste meters, the CO_2 and temperature may be recorded on separate Type M instruments properly calibrated, or else a new instrument just developed may be used and the temperature and CO_2 recorded on the same chart. This instrument, the Type D M is built on the same principle as the Type M, but carries 2 pens and gives a chart as shown in Fig. 4.

DURABLE BELT LACING

Steel Lacing Adapted to Belts of All Kinds

ALLIGATOR steel belt lacing is adapted for use on leather, rubber, balata, cotton or canvas-stitched belting. The flexible joint insures quick contact with the pulley, whether the belt is run with either or both sides in service, and as the lacing engages both sides of the belting alike, the strain is thrown in a direct line of the pull, making

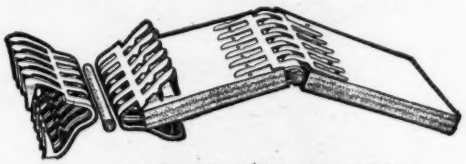


FIG. 1. ALLIGATOR STEEL BELT LACING

a joint which is easy on the belt, and where applied according to directions will stand any strain put on a belt under any conditions of service.

With rubber or textile belting this lace overcomes the tendency to fray at the ends, as the members of the lace clamp the stub so as to protect them.

FIG. 2. ENLARGED SECTIONAL ROCKER HINGE PIN

The teeth on each side of the lacing enter the belt on different lines of perforation; each prong has 2 teeth, the longer clinching through belt, the shorter point on the opposite side of prong giving great additional strength. Both enter the belt so that the pull is against the edge of the steel and not against the flat. This avoids weakening the belt, and in rubber and textile belts does not cut the long threads in which lie the strength of that class of belting.

Being separable, this lacing is especially adapted for use on overhead belts, the ends can be dropped down, the lacing applied and hinge pin inserted after the belt is returned to the shafting; by taking out the pin, the belt may be temporarily removed from service, lengthened by inserting a stud section of belting or shortened by cutting off excess from one end and using half of a new lacing.

The connecting bar between the prongs is indented on the under side to allow it to be broken into required lengths and the use of a single section on any width of belt up to 12 in. The indentation also insures that in use over heavily crowned pulleys the bar may be broken without weakening the lacing, as each indentation separates a full staple which retains its efficiency.

Sectional rocker pin consists of 2 specially formed steel wires having oval faces with lugs on back to fit in between the loops of the hinge and keep it from working out. In service the sections of the pin remain stationary in the loops of the lacing and give the necessary flexibility to the joint by rocking on their oval faces.

Flexible Steel Lacing Co., Chicago, is the manufacturer.

ALCHEMY AND METALLURGICAL PROGRESS

ALCHEMISTS, who have existed from time immemorial, have generally been considered impractical dreamers or charlatans, ever seeking to transmute base metals into gold. But they were really the scientific investigators of their day to whom we are indebted for many useful discoveries and inventions, particularly in chemistry and metallurgy.

Alchemy went down and out in England in a tragedy and in Germany in comedy about 1782.

James Price of England, and Semler of Germany, were among the last alchemists of note. Price was a distinguished chemist and a Fellow of the Royal Society of England. He claimed that he could produce gold from base metals and when called upon by a committee of the Royal Society to make good his claim in their presence, he committed suicide rather than face the ordeal. About the same time the German Alchemist Semler, who was experimenting along similar lines, discovered a precipitate of gold in his mixture; he tested the accuracy of his results repeatedly, and then like a true unselfish scientist, freely gave out his discovery. People everywhere endeavored to make gold by Semler's process and as they could not produce results, the matter became a scandal and was investigated by the German government, which discovered that a faithful servitor in Semler's employ was so anxious that his master should succeed that he practiced self-denial that he might be able to purchase gold leaf and secretly put a small quantity of gold leaf into each experimental mixture.

Metallurgy advanced steadily and the advent of the practical steam engine necessitated studying the question of frictional resistance. Among the first noted investigators was Coulomb and his work excited such interest that the French Government appointed General Morin to make still further experiments, the records of which were published in the Memoirs de L' Institute in 1833. We are indebted to General Morin for the first enunciation of the laws governing friction, which is all the more remarkable, as his results were obtained by means of a sled operated upon a straight track.

In the year 1799 was born Isaac Babbitt in Taunton, Mass. Mr. Babbitt became a jeweler by trade

and also manufactured Britannia ware, but did not, as is generally supposed, patent the composition which bears his name. His patent, taken out in 1839, merely covered the process of lining boxes with a soft metal by soldering the lining to its backing and he recommended the use in this connection of "Britianna metal or pewter." Congress voted him $20.000 for the use of his patent and Massachusetts presented him with a gold medal, but his name will go down through the ages as the inventor of "Genuine Babbitt." Mr. Babbitt properly deserves this credit, because prior to his discovery that a white metal alloy could be used to advantage on machinery bearings, it was thought unsafe to use any composition softer than brass or bronze.

Naturally, mechanics busied themselves experimenting with other alloys and among these experimentors was Samuel Singley, a rolling mill superintendent, who carried on his experiments and practical tests for 20 yr. or more. He finally produced an alloy superior to and cheaper than Babbitt, which was finally placed on the market and is now used throughout the mechanical world and is known as Magnolia Anti-friction Metal.

MEASURING THE EMULSIFIED OIL IN CONDENSATE

ORDINARILY it is not difficult to detect the presence of free oil in water, since, given sufficient time, the oil will make its appearance on the surface. It is not always so easy, however, to detect emulsified oil, which is nearly always present in the condensed exhaust from reciprocating engines, pumps and other apparatus where a good oil separator is not installed in the exhaust steam line. Formerly, it was customary to dissolve grease out of surface condensers, closed heaters, heating coils, etc., by means of a strong solution of caustic soda, caustic potash, or lye, but as modern cylinder lubricants are composed chiefly of mineral oils, this can no longer be done, as mineral oils are not saponified or otherwise affected by alkaline basis.

As stated above, that part of the oil which remains as free oil will come to the surface, and may be removed from condensate by skimming, but with the high steam pressures and temperatures now employed, this method does not prove satisfactory, for even after all the free, visible oil has been removed, the condensate still has a bluish, opalescent or milky appearance, which persists after days or even weeks of standing. The modern theory is that this oil is present in the water in an emulsified or collodial condition, that is, it is subdivided into minute globules, each of which carries an electrical charge that prevents coalescence of the separate particles.

Under a high power microscope, the small particles of oil may be actually seen and measured, some being as small as a millionth of an inch in diameter. Nevertheless, when condensate containing such emulsion is heated to a high temperature in the boiler, these particles coalesce, forming free oil.

Some degree of success has been met with in removing this emulsified oil by stirring powdered substances into the water, creating heavy flocculent precipitates. Therein by the use of alum and soda ash, setting free in the water electrified particles or ions bearing electrical charges of opposite sign to the electrical charges of the oil particles, etc., but none of these methods appear to have reached any great success, at least in this country, although it is a well known fact that where a heavy deposit of sludge and scale forming matter is formed in settling tanks or softening systems, oil rarely makes its appearance in the boilers using the treated water. This is doubtless due to the fact that the precipitate entangles the oil particles and this clears the water of them. In general, however, little reliance is to be placed upon any means for removing the oil from the steam after it is condensed. Recourse should rather be had to oil separators of an efficient design and ample size properly installed in the exhaust steam main ahead of the apparatus in which the steam is to be condensed.

The presence of oil in boilers being recognized as highly dangerous, and the removal of oily emulsion from water being a most difficult matter, the detection of oil in proposed boiler feed supplies becomes highly important, especially if it is possible to use condensed returns, which are otherwise practically chemically-pure distilled water and ideal for boiler feed purposes in all other respects. Considerable interest, therefore,

USING MARTIN TEST TUBE

attaches to the instrument for detecting oily emulsion which we illustrate herewith. This is known as the Martin test tube, and is sold in the United States by the Harrison Safety Boiler Works, Philadelphia, Pa.

This instrument is in reality a long test tube, made of clear glass, except at the bottom, which is opalescent or milky, with a small black dot in the center. The manner of using the instrument is to collect in a glass or cup a sample of the condensate to be tested, and then taking the tube to a good light from a north exposure, that is, neither direct sunlight nor electric light, but rather to strong, diffused daylight, pour the water slowly into the tube, until the black spot just disappears from view. The graduation on the tube which is then opposite the level of the water in the tube will show the amount of oil in emulsion, in grains per U. S. Gallon. The results obtained by these tubes have been repeatedly compared with analyses made by the chemists of the Harrison Safety Boiler

Works, and the tube is reported to be substantially correct. It is necessary, however, to use certain precautions in its use, viz.:

1. Care should be taken that the light in which the tube is used is about the same at all times, the most satisfactory light being daylight, but not direct sunlight. If the tube is used by electric light, higher results will be indicated than by natural light.

2. The tube should not be used with water containing free oil floating on the surface, since the method applies only to the oil present in emulsion.

3. Before testing the water, care should be taken to see that it contains no suspended matter in form of precipitated organic or other solids, since these will give an erroneous result, indicating more oil than is actually present. In the case of condensate from heating systems and condensers, however, this trouble is rarely encountered.

4. If the inside of the tube should become fouled with oil or other matter, it should be cleaned with a little chloroform or ether, and afterwards rinsed with clear water.

These tubes are sold by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, at a small price, and have proved very useful in several instances in ferreting out the sources of oil in boiler feed supplies, in testing the efficiency of different types of oil separators, in determining the degree to which different grades of cylinder oil emulsify, etc.

LUNKENHEIMER PUDDLED SEMI-STEEL VALVES

INCREASING use of high pressures and superheated steam has created a demand for something better than the ordinary cast-iron, brass mounted valves, and the Lunkenheimer Co. has developed its line of Puddled Semi-steel valves for this service.

Puddled Semi-steel is an iron and steel alloy, of close grain and great strength. The method of making this alloy is to melt the iron and steel together in a modified puddling furnace, thoroughly mixing them during the process, and by pouring off at the proper time and temperature, a uniform alloy is secured.

By this process it is possible to control the tensile strength at any point between 30,000 and 40,000 lb. per square inch. Ordinarily, the strength maintained is 35,000 lb., which is about 50 per cent stronger than that used in cast-iron valves.

These valves are made in 2 combinations as regards the material used for the trimmings, and are designated as Combinations C and D. The object of these combinations is to suit various conditions of superheat and to meet the specifications of engineers who differ as to the metal that should be used in the trimmings. Combination C is guaranteed for 600 deg. F. temperature and Combination D for 550 deg. Both combinations are suitable for 250 lb. pressure per square inch. The line includes globe, angle, cross, check, gate, non-return safety boiler stop valves, etc.

AT THE College of Engineering, of the University of Illinois, the registration for 1912 shows 1149 students in the under-graduate courses. About 250 are registered in each of the Departments of Civil, Electrical and Mechanical Engineering, about 330 in Architecture and Architectural Engineering, and the remainder in Mining, Sanitary and Railway Engineering.

NEWS NOTES

A DISTRICT OFFICE has been established by the National Tube Co., in Boston, to take care of the interest of patrons in that vicinity.

THE JOSEPH DIXON CRUCIBLE CO. sends notice of the death of its honored Vice President, William H. Corbin, on September 25, at his home in Jersey City.

TO ACCOMMODATE the increased demand for its products in the Pittsburgh District, the Durabla Mfg. Co. has opened a branch office in the Westinghouse Building, in charge of J. L. Hopkins.

DEAN JOHN P. JACKSON, of the School of Engineering, Pennsylvania State College, reports 354 freshman in the engineering courses and a total enrollment of 964 to date.

C. H. WARFIELD, secretary and treasurer of The Goulds Manufacturing Company has resigned his position with that company. B. R. Wells has been appointed treasurer and H. S. Fredenburgh, secretary, to succeed Mr. Warfield.

AT THE MEETING of the Council of the Institute of Operating Engineers, L. Houmiller was appointed Executive Secretary in place of H. E. Collins, whose term expired and who is too busy to give the necessary time during the coming year. The office of the Institute will be as heretofore, at 29 West 39th St., New York City.

THE WHEELER CONDENSER & ENGINEERING CO., of Carteret, New Jersey, manufacturers of high vacuum surface and jet condensers and general condensing machinery, announce that they have opened an office in Cleveland, Ohio, at 1325 Citizens Building, which will be under the management of Walter G. Stephan.

PREVIOUSLY THE ONLY ROUND bulb Edison Mazda Lamps available for 100 to 130 volt circuits were the 15, 25, 40, 60, 400 and 500 watt sizes. On October 1, 1912, the General Electric Company added 2 new intermediate sizes, namely the 100-watt and 150-watt sizes. This addition gives the user nearly the same wide range of sizes now available in the standard, or pear shaped bulbs.

CARLISLE MASON, for many years vice-president and general manager of the Nelson Valve Co., of Chestnut Hill, Pa., has resigned his position with that company. Under Mr. Mason's direction, the Nelson Valve Co. has developed a line of valves specially designed to resist high pressures and superheat, and has built a works among the largest and most modern of those devoted to valve manufacture.

EXAMINATION WILL be held on November 11th for Mechanical Draftsman in the Engineer Department at large, located at Milwaukee, Wis., salary $900 a year. Examination will be in General Education, 20 points; Technical Training and Experience, 60 points; Practical Tests, 20 points. Statements in regard to education, training and experience accepted subject to verification. Requirements are, age 18 years or over and citizenship in United States. Application should be made to the Secretary of the 7th Civil Service District, Post Office, Chicago, for Examination Form 1312, and the application and form, with all data, should be filed by November 11.

EXAMINATION WILL be held on November 6th to 8th at principal cities in the country for Draftsman on Marine Engines and Machinery. Positions to be filled are, one in the Bureau of Light Houses, Washington, D. C., $1380; one at Tompkinsville, N. Y., $1500; one in the Revenue Cutter Service, Treasury Dept., Washington,

$1400, and others as they may occur. Examinations will will be in Mathematics, 10 point; Materials, 10 points; Calculations, 10 points; Drafting, 20 points; Experience and Training, 50 points. Three days will be required for the examination, and a percentage of at least 70 must be secured in Experience and Training in order to receive the appointment. Age limit, 18 years or over; open to all citizens of the United States. Application should be made on blanks to be secured from U. S. Civil Service Commission, Washington, D. C., Form 1312.

AT A MEETING of the Executive Committee of the National Gas Association in Indianapolis, arrangements were made for the coming annual meeting of the Association at the Claypool Hotel in that city. The meeting will extend from December 3 to 5, the first day being devoted to reports of committees, the president's address and discussion, and a meeting of the Engine Manufacturers' section. Other days will be devoted to technical papers and discussions, with entertainment in the evenings. Papers will be presented on Gas Engine Design by Prof. C. D. Wagner; a Timed Alternating Magneto, by W. W. Gore; Gas Producer for Power and Foundry Service; Gas Engine Economy, by A. E. Potter; Two-Cycle, Two-Cylinder Opposed Engines, by Ben Heer; Gas Engine Paints, by G. W. C. Sedgewick; Illuminating Gas for Industrial Power, by H. W. Jones; and other papers to be announced later. The customary arrangements for exhibits will be made and reservations for space should be sent to R. A. Oglesby, Hercules Electric Co., Indianapolis, Ind., or Albert Stritmatter, 224 E. 7th Ave., Cincinnati, O.

EXAMINATION WILL be held for Heating and Ventilating Draftsman in the office of the Supervising Architect, Treasury Department, Washington, D. C., at a salary of $1200 a year, and other vacancies as they may occur. The subjects will include, Heating and Ventilation, theoretical and practical, 35 points; Drawing and Design of Heating and Ventilating Plants, 35 points; Training and Experience, 30 points. Examinations will be held on November 20 and 21, in the principal cities in the country, applicants providing their own drawing instruments and materials other than paper, including drawing board not less than 18 in. square. Applicants must have had not less than 4 years' practical experience in designing or installation of plumbing, heating and ventilating systems in large buildings. An applicant must be examined in the state in which he resides, must be 18 years of age or over and a citizen of the United States. The examination will last 6 hours on November 20, and 7 hours on November 21. Application should be made on Form 1312, to be obtained from the United States Civil Service Commission, Washington, D. C., and should be filed in time to permit the shipment of the necessary questions to the place where the examination is to be held.

THE UNITED STATES CIVIL Service Commission will hold an examination for Mine, Sanitary Engineer in the field service of the Bureau of Mines, at salary of $1800 to $2400 a year. The duties will be to study sanitary and water supply conditions in mines and mining towns, in order to improve the welfare of the miners. Graduates of an engineering school or college, who have taken a course in sanitary engineering, are eligible. The subjects will be, Education and Technical Training, 30 points; Technical Experience and Fitness, 35 points; Experience of Conditions in Mining Towns, 15 points; Articles or Thesis on Sanitary Engineering, 20 points. Letters of recommendation from teachers or colleagues may be submitted under the second subject. Applicants must be between 25 and 36 years of age, and statements as to training, experience and fitness are accepted subject to verification. Those desiring the examination should apply for Form 304 and special form to the Civil Service Commission at Washington, D. C., or the Secretary of the Board of Examiners at the Post Office in Boston, Philadelphia, Atlanta, Cincinnati, Chicago, St. Paul, Seattle, San Francisco or the Custom House in New York, New Orleans or Honolulu, or the Old Custom House in St. Louis. Applications should be filed with the Commission at Washington, in complete form, by November 9th.

Bureau of Mines is to appoint a Mineral Technologist for field service at Denver, Colo., at a salary of $3000, to study the rare mineral industries as to occurrence, mining, and preparations of treatment. Subjects for examination of applicants for this position will be, Educational and General Training, 30 points; Experience in connection with Rarer Minerals, 40 points; Publications of Technical Reports, 30 points; Training equivalent to that required for graduation from a technical mining course is required. Under the subject of experience, full details should be given of all experience in prospecting for mining and treatment of the rare minerals. Applicants must be between 25 and 40 years of age, and a citizen of the United States. Application should be made for Form 304 and special form to the Civil Service Commission, Washington, D. C., or the postoffices as given in the preceding paragraph. Application and other materials should be filed with the Commission at Washington by November 8th.

A. S. CAMERON STEAM PUMP WORKS announces removal of its offices to the Bowling Green Building, 11 Broadway, N. Y., on the 16th floor, where all friends are now welcomed. A new storeroom has also been established at 511 West 42nd St., New York, where a line of pumps and parts will be carried for the greater convenience of customers.

CATALOG NOTES

DURABLA DISCS, made from a scientific German compound, manufactured by the Durabla Mfg. Co., of New York, are described in a pamphlet obtainable from the company.

MARTELL PACKINGS as made by the Metallic Packing & Mfg. Co., of Elyria, Ohio, for steam and gas engines, pumps, hydraulic presses and air compressors, are shown in Catalog G, recently issued.

THE 10TH EDITION of a book entitled "The Test of Actual Experience," and containing testimony and arguments for wrought iron pipe vs. steel pipe, is received from the Reading Iron Co., of Reading, Pa., and embodies much matter relative to this important subject.

BULLETIN B-1 of the American Stoker Co., of New York City, describes the Class E Stoker, which is of the double inclined grate type, feeding at the center, and dropping the ashes at the sides. A full description and details are given in the catalog.

THE ALBANY Sectional Shaking Grate, made by the Geo. H. Thacher & Co., of Albany, N. Y., is shown and described in Bulletin A. The different parts, how they are assembled and how the complete grate acts, are all clearly shown.

A SYSTEM FOR RETURNING the water of condensation from steam pipes to boilers, is described in the booklet on the Holly Gravity Return System, issued by Westinghouse, Church, Kerr & Co., of New York City. It shows in outline the installation of a typical system and explains its advantages.

YALE AND TOWNE chain blocks, electric hoists, trolleys and cranes are interestingly described and their purposes shown, in a booklet sent out from the general offices at 9 Murray St., New York City. The illustrations show exactly how the triplex block is put together and how it works. The different styles are the triplex, the duplex, and the differential and also electric triplex hoists, and Brownhoist steel trolleys used with electric hoists. The whole system is one of labor and time saving for handling coal or any other material about a plant.

CATALOG B, issued by the Alberger Pump and Condenser Company, of New York, describes fully the Alberger Centrifugal Pump and Alberger Steam Turbine. It contains 72 pages of interesting descriptions and illustrations and has also a number of tables of useful values. Diagrams are also given from which the variation of power with the amount of water pumped, variation of head with speed, and variation of efficiency with load can be quickly determined for centrifugal pumps of the size as given. Complete cross section views of the turbine pump are shown, giving a clear idea of just how this type of pump works and the shape of the pump as used in the Alberger Construction.

FORM 3109, A BULLETIN of twelve pages on compressors, issued by Ingersoll-Rand Co., describes class NF-1 steam driven, single stage, straight line, air compressors; twin flywheel, center crank, enclosed type, with the steam and air cylinders arranged in tandem. Catalog shows several views of the machine in section, and also gives tables of cylinder diameters, dimensions and capacities. Air inlet valves on the smaller machines are of the direct lift type; on the larger machines hurricane inlet valves are standard. Cushioned direct lift discharge valves are standard on all sizes.

THE 17TH EDITION of tables and other data for engineers and business men, compiled by Charles E. Ferris of the University of Tennessee, is just available and is a notable advance over previous editions in clearness of type, convenience of arrangement and the matter contained. It is furnished in leather binding, for 50 cents, and is a most convenient hip pocket companion.

CATALOG No. 15 from Manzel Bros. Co., 327 Babcock St., Buffalo, N. Y., describes the new Manzel sight feed oil pump for cylinder lubrication called Class H-A. This is designed for lubricating the cylinders of steam engines and pumps, gas engines, ammonia compressors, plunger elevators, etc. It is an oil saving device as well as insuring positive lubrication and shows just what the Manzel pump is and how it goes about its work. Copies of the catalog may be had by writing to the manufacturers at 327 Babcock St., Buffalo.

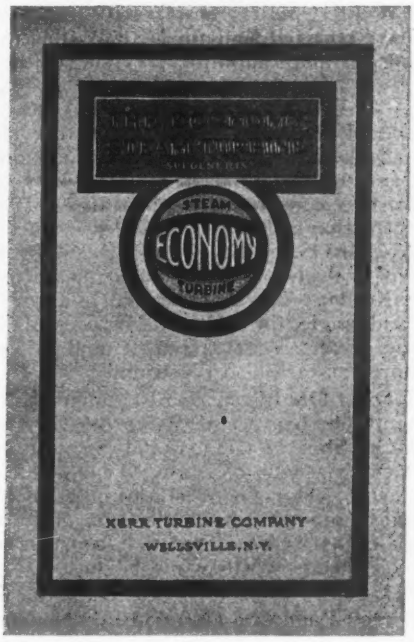
THERE HAS just been issued by the General Electric Company an attractively bound book of 132 pages, devoted to the use of the "higher voltages" in the operation of Direct Current Electric Railways. The bulletin sets forth the advantages of the "higher voltages" in this connection. It contains numerous tables comparing the various costs of 1200 volt systems as compared with those of 600 volts, illustrates and describes station and car equipments, locomotives for railroads of higher direct current voltages, and describes the various systems employing direct current at 1200, 1500 and 2400 volts. The bulletin contains a large amount of information both of interest and value to electric railway operators. The number of this publication is 4958.

Bulletin No. 4771, entitled "Hand-Operated Starting Compensators for Alternating Current Motors," supersedes previous bulletins on this subject.

Bulletin No. 4763, entitled "Isolated Plant—Direct Current Combination Generator and Feeder Panels," supersedes the previous bulletin issued by this company on that subject.

The General Electric Co. has superseded its old bulletin on "Centrifugal Air Compressors for Industrial Air Blast and Exhauster Service," by Bulletin No. 4774.

"ECONOMY STEAM TURBINE," is the title on the cover of a handsome catalog issued by the Kerr Turbine Co., of Wellsville, N. Y., and showing the details of construction of this machine, its application



to pumping, to blowing, to electric generating, and illustrating the wall space occupied and the convenience of operation and making repairs. The 95 pages of the catalog are full of interest and instruction.

THE NEW CATALOG, "Manila Rope," issued by C. W. Hunt Co., of West New Brighton, N. Y., contains much interesting matter on the manufacture of rope, the development of rope transmission, the data needed for designing rope transmissions and the complete directions for splicing rope. The whole forms a handsome book of 50 pages.

SWEET steam and oil separators, type of 1912, as made by the Direct Separator Co., of Syracuse, N. Y., are shown in detail in a completed catalog issued by the Schade Valve Mfg. Co., of Philadelphia, Pa.

BULLETIN 4023 describes and illustrates the "4-E" type of Electric-Air Rock Drill manufactured by the Ingersoll-Rand Co., 11 Broadway, New York City. This machine will operate with either direct or alternating current; has a cylinder diameter of 4¾ in., 7-in. stroke and will drill a 1¼-in. to 2-in. diameter vertical hole up to 12 ft. deep.

BRADBURY BLOWOFF valves, made by the English Tool & Supply Co., of Kansas City, Mo., have no packings and provide for a free and clear exhaust opening. They are shown in the pamphlet issued by the manufacturers.

BULLETIN NO. 111, issued by the Goulds Mfg. Co., of Seneca Falls, N. Y., describes the Goulds centrif-

ugal sump pump, which is made in 2 sizes, 1 and 2 hp., and capacities of from 70 to 210 gal. per min., according to the head. The design of this self contained unit is interesting.

"TERRY TURBINES Handle Peak Loads," is the title of a handsome booklet just issued by the Terry Steam Turbine Co. On the flyleaf cover there is tipped a color print, really suitable for framing, of the famous mountain of Japan, Fujiyama. This booklet tells what Terry turbines mean to central stations, and will be sent by applying to the nearest office of the Terry Steam Turbine Co. or to the company's general sales office, 90 West St., New York.

FROM TRIUMPH ELECTRIC CO., Cincinnati, O., we have received Bulletin No. 501, illustrating and describing Triumph-Monitor reversing motor planer drive.

IN A 36-PAGE catalog issued by the Munning-Loeb Co., of Matawan, New Jersey, the subject of buffing and polishing wheels is gone into quite thoroughly, and over 20 different styles of buffs manufactured by this company are illustrated. Much practical information of interest to buffers is included.

DEAN BROS. STEAM PUMP WORKS, of Indianapolis, Ind., has a new catalog on power pumps, Catalog No. 90. These are shown in throttled style, duplex and single, for high and low pressures, for belt or motor drive. Vertical pumps and power driven air compressors are also illustrated.

SMOOTH-ON Instruction Book No. 12, tells about the Smooth-On Iron Cement, Smooth-On Iron Paste, Smooth-On Sheet Packings and Smooth-On Corrugated Metal Gaskets, and also when, where and how to use them. 100 pages of data of other men's experience, and of practical instructions on how to fix difficult repairs, as well as good first construction, make up a book that is worth while having.

FORM 4209, 16-page, 6 by 9 bulletin, issued by the Ingersoll-Rand Co., 11 Broadway, New York City, describes the Temple Ingersoll-Electric-air rock drill, manufactured by them. The Electric-Air drill is driven by pulsations of compressed air created by a pulsator actuated by a standard electric motor. The air is never exhausted, but is simply used over and over again, playing back and forth in a closed circuit. The drill is very simple—a cylinder containing a moving piston and rotation device, with no valves, chest, buffers, springs, side rods or pawls. The pulsator requires no intake or discharge valves or water jackets. It is geared to a motor, either direct or alternating current, and mounted on a wheel truck for easy handling. Two short lengths of hose connect pulsator and drill, each hose acting alternately as supply and exhaust. The Electric-Air drill under ordinary conditions, uses about ¼ the horsepower required with the usual air steam drill, of the same work capacity. Catalog is finely illustrated to show drill in section and at work.

CATALOG 384-F, issued by the Ingersoll-Rand Co., 11 Broadway, New York City, gives instructions for installing and operating the Temple Ingersoll Electric-Air rock drills, and Form 601 gives instructions for operating the "5-F" machine, together with list of duplicate parts.

WORCESTER BRUSH & SCRAPER CO., of Worcester, Mass., manufacturers engineers' supplies including boiler tube cleaners, flue brushes, gage glass cutter, and similar materials all of which are fully described in a convenient pocket catalog recently received.

BULLETIN 4025, Ingersoll-Rand Co., 11 Broadway, New York City, describes the "5-F" Electric-Air Rock Drill, which will drill holes 1¾ in. to 2¾ in. diameter up to 20 ft. deep. It has a cylinder diameter of 5⅝ in.; stroke, 8 in.; uses octagon steel, and will drill a 30-in. hole without change of bit.

A CASH REGISTER for the Coal Pile is the title of a 6-page publication issued by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, describing the Cochrane Combined feed water heater and meter. The Meter itself is a simple V-notch weir, and by its incorporation in the construction of an open feed water heater, advantage is taken of the fact that all boiler feed supplies, including the raw make-up water and the returns, discharges from traps, etc., are brought together in the heater prior to being fed to the boiler.

The rate of flow is recorded by means of a large float, which operates a simple mechanical recording gear. The record therefore shows the instantaneous rate of flow at any moment during the period covered, and by integrating the area of the chart, the total flow may be obtained. The performance of triangular notched weirs when mounted in chambers of the proper size has been carefully investigated, and the Harrison Safety Boiler Works guarantee the accuracy of its meters within 1½ per cent of absolute accuracy by weight, this figure including all variations due to changes in temperature not exceeding 50 deg. F.

TRADE NOTES

IN CONNECTION WITH the revival of business this Fall, a noteworthy feature is the greatly increased activity in the re-equipment or extension of water works pumping plants, both municipal and industrial, with high efficiency pumping engines.

Among recent contracts for pumping engines reported by Allis-Chalmers Co., Milwaukee, are the following, having daily capacity as given; Toledo, Ohio, 1 30 million gallons; Hopkinsville, Ky., 1 1¾ million gallons; St. Paul, Minn., 1 1½ million gallons; South Bend, Ind,. 2 5 million gallons; Independence, Kan., 1 4 million gallons; Havana, Cuba, 1 5 million gallons; Waco, Texas, 2 5 million gallons; Winfield, Kan., 1 3 million gallons; Pittsburgh Steel Co., 5 15 million gallons; Peoria Water Works, Peoria, Ill., 1 10 million gallons.

They also report an order from the General Construction Co., San Francisco, California, for 11 26 by 42 by 36 in. engines for operating oil pumps for pipe line pumping service.

THE GARDINER-BEARDSELL CO., Nashua, N. H., has recently purchased a set of Macdonald shaking grates, made by the Robb Engineering Co., Ltd., for a 65-in. boiler; and the Stewart Boiler Works, of Worcester, Mass., have purchased a set of these grates for a 60-in. boiler.

MOST EVERY MAN around a power plant carries keys and has use for a substantial key chain. And everyone who wants one badly enough to send his name and address to the Perolin Company of America, 1122 W. 37th St., Chicago, will get a Little Dutch Kid souvenir key chain free, by return mail.

THE BROWNELL CO., Dayton, O., announces the redesigning of its Enclosed Self Oiling high-speed engine. A number of important changes have been made, which have increased the efficiency and simplified the problem of manufacture. Literature describing the new features of this engines will be ready for mailing at an early date.

Sparks From The Advertising Pages

Modern advertising embraces far more than the average reader is apt to realize, especially one who is not versed in the more up-to-date methods of publicity. He looks through the pages of a magazine, notes certain advertisements that seem to be good ones and speculates on the immense amount of business which those advertisements must be bringing.

But this is merely the spectacular part of the advertising—only one of many links in a successful publicity chain. The reader forgets or doesn't know of the catalogs which must be prepared, the strong, convincing special literature that must be sent to the prospect who has read and answered the advertisement. And perhaps he doesn't know of the carefully written sales-letters with their compelling follow-ups.

If a manufacturer merely had to put some good advertising copy in some good magazines —if this were *all* that is necessary in order to sell goods, publishers would have to employ policemen to keep these manufacturers from mobbing their offices. They would be frantic to insert space here—there—everywhere; for the more advertising they inserted the more goods they would sell.

But a successful advertising campaign is necessarily much more complex.

When a manufacturer launches a new product upon the market he often has to wait a while before his advertising has gained the confidence of his prospective buying field, even though every detail in the campaign has been the recipient of much careful thought and study.

He makes every link in his advertising chain strong. His advertising copy is written by experts. His space is bought with discriminating judgment. His descriptive literature is perfectly welded with gripping sales letters.

Like the farmer who went to the well, he doesn't expect his chain to pull up the bucket of results until it is made long enough to grip it and strong enough to hold it. So he patiently adds on his links with the full realization that when his campaign is *long* and *strong* enough he will get what he is after. And he knows, too, that the links at the beginning or top of the chain were just as important and did just as much work as the last few, even though the latter were the ones which seemed to bring about the desired results.

This very complexity of a successful campaign puts a premium on the quality of the product which is advertised for sale. It makes it absolutely imperative that there be no misrepresentation—that the product shall embody all of the qualities which are claimed for it—that it shall be well worth while.

A thoroughly good product is the foundation or starting point of any ultimately successful advertising campaign; for after the manufacturer has a grip on his buying field and the results are coming in, it is then up to the product itself to hold the trade on its own merits. It is the pivotal link in the chain and unless it is strong, the strength of the other links is worthless.

You wouldn't invest good money to build a chain in which you knew your most important link was a weak one. Likewise the advertisers in Practical Engineer are too shrewd to advertise products which will not hold your good will after you've bought them.

Bank upon the advertised product. It's always reliable.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—By young man as oiler or engineer's helper. Graduate of engineering. Two years' experience with gas engines. Address J. B. Johnson, Engr., Laurel, So. Dak. 11-1-1

Wanted

WANTED—October 1st, 1912, issues of Practical Engineer. Your subscription extended 2 months for every copy of this issue sent us. Offer good until Dec. 1st, 1912.

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write the Subscription Dept. They will start you in at once. tf

For Sale

FOR SALE—1 C. H. WHEELER MFG. CO. Improved Jet Condenser with 16-in. exhaust opening mounted on 1 10 by 18-in. horizontal, simple, direct, double acting air pump. (This condenser is supplied with a 24 by 16-in. flanged cast iron reducer, so that it may be connected to either a 16 or 24-in. exhaust pipe.) This condenser has a capacity of about 10,000 lb. of exhaust steam per hour with 70 degrees cooling water and 26-in. vacuum. The condenser is of the C. H. Wheeler Standard Jet Type, consisting of cast iron cone with openings for exhaust and injection water connections and provided with injection distribution plate and vacuum breaking device designed to open a connection to atmosphere for breaking the vacuum to prevent the injection water being drawn into the engine should the pump fail from any reason. The condenser is mounted on the pump. The pump is of the horizontal, single, direct, double acting, steam driven design, brass fitted; the pump cylinder is of high grade cast iron provided with brass liner; pump piston of brass and pump rod of Tobin bronze; valve seats, bolts and guards of brass, and valves of rubber composition. The steam cylinder is of high grade cast iron; the steam piston of cast iron with snap rings. The valve gear is of the Wheeler Improved Design, insuring full length of stroke at any speed. Necessary drains, spanners, wrenches and lubricators are included. Condenser and pump are of best quality, workmanship and material and were tested under pressure before being shipped from the manufacturer. They have never been in service. Address G. S. B., Box 1580, Milwaukee, Wis. 11-1-1

FOR SALE—New 30 H. P. Ball Automatic Horizontal engine. Lucas & Son, Bridgeport, Conn. 9-15-6

Help Wanted

WANTED AS FOREMAN—An Engineer and Machinist, 35 to 45 years of age, whose experience has been in important manufacturing and steam plants. Very competent man with best of experience and references required. Address Box 257, care of Practical Engineer, Chicago, Ill. 11-1-1

WANTED—By Ohio Manufacturer, Draughtsmen experienced on return Tubular Boiler work. Must be able to lay out work and develop sheets. State experience and salary expected in first letter. Addrss Box 255, care of Practical Engineer, Chicago, Ill. 11-1-1

AN EXTRAORDINARY OPPORTUNITY for party or parties with some knowledge of mechanics, not necessarily practical, with small capital. State or county rights for sale of an established patented device. Quick sale in all manufacturing districts. Exceptional profits. Address P. O. Box 489, Trenton, N. J. 10-15-2

WANTED—By Ohio Manufacturer, Draughtsmen experienced on High Speed Automatic Engine Work. State experience and salary expected in first letter. Address Box 256, care of Practical Engineer, Chicago, Ill. 11-1-1

Patents and Patent Attorneys

THE PATENTOME is interesting and instructive. A liberal education in patents and how to get them. Free on request. Established 1865. Anderson & Son, Patent Solicitors, 710 G St., Washington, D. C. 11-1-2

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 608 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf. e.o.i.

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owens, 28 Owen Bldg., Washington, D. C. tf

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PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building. Washington, D. C. tf

Miscellaneous

FOR TRADE—Stock of Groceries and Queensware acquired by Engineer in settlement of estate,—for small Compression Ice-Plant. Address Box 258, care of Practical Engineer, Chicago, Ill. 11-1-2

IRON, BRASS and Aluminum Castings, Metal Specialites, Patterns, Models, Polishing, Plating and Japanning, North Chicago Tool Works, 65 Grove Ave., North Chicago, Ill. 6-1-12

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash-Younker Co., 1413 W. Jackson Blvd., Chicago, Ill. tf

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